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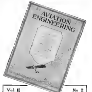

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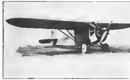

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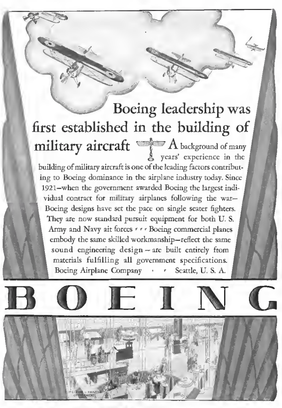

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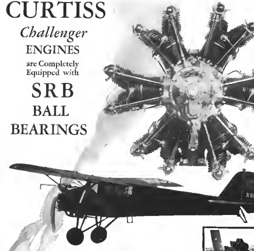

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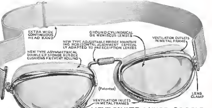

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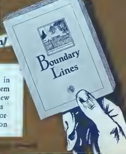

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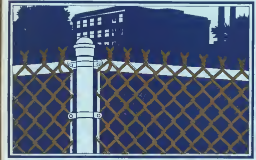

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Harry S. New

THE fundamental principles along which it is planned to develop a new business are of major importance Details can be worked out to perfection, but if the foundations are unsound failure is sure to follow Conversely, if the foundations have been correctly laid the business will prosper in spite of imperfect details This is the reason that executives who have a successful record for laying down and following out sound ideas, receive rewards which seem to many to be out of line with the work which they have actually done.

In the development of our air mail we have been fortunate in having in the Post Office Department men of vision who could see in it a great stimulus to commerce, and who had sense enough to direct its development along sound lines Postmaster General Harry S New, who retired on March 4, was one of these leaders During his tenure of office certain moves were made which will have a permanent effect on the development of the air mail, and from all present indications the moves were made along very sound and progressive lines In the first place, the flying of the mail has been transferred from the Government over to private contractors Further, a scheme has been worked out which will permit a satisfactory contractor to hold his contract for as long as he performs satisfactory service.

The extension of our air mail service to South America will, however, stand out as the most important achievement of Postmaster New's regime. He has been the moving power behind this development and it is probable that, without his influence and energetic backing, this service would have gone by default, and would have been taken over by foreign countries The air mail service to South America should be an enormous benefit to our trade, and will be worth more than the cost of the whole air mail development to date Postmaster New can retire with the feeling that he has done something of real benefit to his country

Nosing Over

THE coming spring days mean mud on the flying fields, and deep sticky mud on the fields mean that planes are apt to nose over Nosing over may mean really serious damage to the plane and injury to the passengers Nosing over is probably an even more frequent cause of damage to planes than running into obstacles To some extent nosing over can be prevented by putting the wheels far forward but this means that great stresses are put on the tail skid and that it is hard to raise the tail for the take off

Various schemes have been tried, varying from the early Wright skids to a series of wheels placed one in front of the other None of these schemes has so far been widely accepted and we still retain the wheels and tail skid arrangement, probaly due to its simplicity There is a real field for development work in this direction The present day wheels offer a very great head resistance. Tail skids dig up the field and put undue stresses on the fuselages The angle at which a plane can be landed is distinctly limited by this factor and by the difficulty of getting the tail up for the take off With so many factors against the present type of landing gear it is more than probable that the planes of the future will not have the present day undercarriages

Passenger Pilots

AMERICAN air mail pilots are as fine a group of fliers as can be found anywhere in the world, but this does not necessarily mean that they can be transferred to passenger transport planes without a certain amount of training The air mail pilot at the controls of a transport plane sometimes does not realize the feelings of the passengers inside the cabin, or he may even be inclined to take advantage of his situation and treat his passengers to a "ride"

On a recent flight across the continent in a combination mail and passenger plane we suddenly found ourselves in a very steep side slip, and the plane finally came out about a hundred feet over a cemetery. The pilot thought this a great joke, but we in the cabin failed to see any humor in the maneuver until some time after it was over Later we were informed that the throttles on two of the engines had stuck and that the switches had had to be cut in order to make a landing Also we were informed that the engines were consuming far too much gasoline and that there seemed to be something wrong with them Later on in the flight one of the pilots practiced blind flying.

Several of the pilots handled their planes rather roughly, putting them into vertical banks before landing or in taking off, or zooming them suddenly and unnecessarily. All this occurred on one trip and in the normal handling of a plane by a mail pilot Probably none of the pilots considered that their flying was of a nature to disturb a passenger, or if they did, they may have considered that they had a right to fly as they wished The selling of flying to the public, however, is not going to be an easy matter, and one of those things which will have to be considered is the eliminating or mitigating of sensations which might inspire fear in the passengers To instill this idea into the minds of pilots who have learned the joys of stunting and who have been flying as they pleased for ten years or more will be a bit difficult, and certain pilots will never learn how resentful a passenger feels when a cabin plane is handled roughly.

Spark Plug Problems

The Relation of Heat Characteristics to Operating Conditions

By HECTOR RABEZZANA
*Chief Spark Plug Development Engineer,
A C Spark Plug Co*

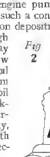
Fig 1

WHEN a spark plug performs unsatisfactorily it is often due to use of a plug intended for another type engine, or a different operating conditions No matter how good a spark plug may be, it will not give satisfactory service if it is of the wrong type Generally the public fails to realize that there is a lot of difference between spark plugs—not only in the quality of the material and workmanship used in their manufacture, but also in the heat characteristics of the plugs themselves

Spark plugs face three problems, pre-ignition, rapid wearing away of the electrodes and fouling Pre-ignition is the result of the plugs becoming red hot and firing a mixture too early, causing pinging and a sharp decrease in the engine's power The fast wearing away of electrodes results from the plugs operating at too high a temperature The fouling of a plug is due to two causes —liquid fuel and oil reaching the gap and combustion deposition over the insulator

Fouling trouble, due to oil or liquid fuel, very rarely occurs in present-day engines, and when it does appear it is generally referred to as "an engine pumping oil" Not only will there be trouble under such a condition, but also valve trouble and excessive carbon deposition Even clean oil will cause trouble through softening the carbon on a plug that may be slightly carbon coated Also a new plug can be short-circuited by oil splash in which floats a small amount of carbon and metallic dust. New oil before it has been placed in the crankcase and become impregnated with carbon is a non-conductor of electricity, but as soon as it becomes filled with carbon, it is then a conductor of electricity

Fig 2



The black coat of so-called carbon which forms over the insulator of a plug is the result of too low operating temperature for that plug When the engine reaches a higher temperature, the insulator also will raise its temperature and automatically burn away the carbon which has piled up during the cold running period But, on the other hand, if the temperature reaches too high a point, it will cause the plug to pre-ignite, or cause detonation These limits of temperature are all worked out by the physical dimensions of the part of the insulator which is exposed to the combustion gases and the overall design of the plug

If the insulators of the plugs become a brownish color, this coat usually has an iron-oxide base, and when this coat darkens in color, because it becomes thicker, it is advisable to change plugs, as they will cause missing at wide open throttle

If a spark plug develops leakage between the shell and the porcelain, the insulator cracks, or the electrode wires wear out too fast, this is a sure sign that the plug used becomes too hot in that engine. A plug made to run cooler has to be used, as will be explained in the second part of this article It is almost impossible to get one type of plug to meet the requirements of different engines, or the different conditions under which the same engine may be used

The spark plug, aside from its service as an igniter, is the only part of the engine that, with visual inspection, can give an exact diagnosis of the condition of the engine Let's analyze a few of them

If a new set of plugs is installed in an engine, and after a few hours of running, without any excessive idling at the end of the run, the plugs are removed and examined, and show a black coat, this will indicate that the type of plug used is too cold for that engine These should be changed for ones with long insulation, which will allow a lower temperature working range so the carbon will burn away, thus preventing the plug from becoming fouled If the plug shows a very white insulator, after a few hours of running, this type of plug is too hot, and it may cause preignition In this case a plug with a shorter insulation should be used

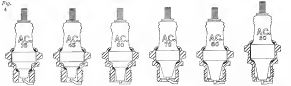
In setting the carburetion, use a spark plug that is known to work right, and if the insulator stays white after a few hours of running, it means that the carburetion is too lean and back firing in the carburetor may happen very easily If the plug reaches a brown color with black spots after a few minutes' run, that means that the carburetion is too rich and it will have a tendency to foul the plug quickly If the porcelain becomes a dark brown color in a very short time and everything else in the engine appears to be all right, including carburetion, most likely the fuel used should be discarded if possible, because not only the plugs will be short-lived, but this fuel will also cause the engine to deteriorate

In altitude flying or on every long hops, the spark plug gaps have to be reduced in size to prevent flash-over on the outside of the plugs If the wearing of the electrodes is not due to excessive engine temperature, or to long use of plugs, it is always traceable to poor fuel Fuel with a high percentage of sulphur should not be used, because it may cause the electrodes and valves to become corroded so quickly that it may put an end to a flight in an unreasonably short time, due to the failure of either the electrode wire or the valves

Lubricating oil also has to be watched in order to avoid the same trouble because the sulphur content may produce sulphuric acid when combined with water, either as a result of condensation or combustion residue In this case the inside of the engine, especially the bearings, will suffer considerably.

When we once learn how to judge engine conditions from analysis of the plugs, it is easy to avoid trouble by choosing the right plug for a given job

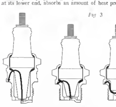
Fig. 4



Of the various characteristics of the ignition spark, its appearance, that is, its fatness, color, etc , does not determine its ignition value It is not possible to add to the power of an engine by adding condensers, retardation coils, auxiliary gaps and the like to the ignition system This statement must be taken as referring to the spark, and not to the spark plug, for it is well known that the use of an improper type of spark plug may cause pre-ignition, and old and fouled spark plugs may cause missing and resultant loss of power

The spark plug, being exposed to the burning gases at its lower end, absorbs an amount of heat proportional to the surface exposed to the heat Part of the heat thus absorbed must pass off through the seat of the plug, but enough should be retained to always keep the plug at a sufficiently high temperature to prevent fouling, as will be explained later

Fig 3



Fouling depends mainly on the temperature of the plug, as can be demonstrated by means of the apparatus shown in Fig 1 Rods of different materials, with holes for thermo-couples in them at definite intervals, are heated in this apparatus, and oil is dropped on the side which is exposed to room temperature The rod is inclined at such an angle that the oil will flow along it If the furnace is maintained at 900 deg C , the oil will begin to carbonize at a certain point along the rod, and will burn off at a point nearer the furnace, where the temperature is still higher The points where carbonization and burning begin vary with different oils, but the differences are slight If the rod is of a material of high heat-conductivity, the temperature gradient will be less and the carbon deposit will extend over a considerable portion of the length of the rod, within which there may be several thermo-couples

The above test shows the desirability of keeping the insulators of spark plugs at a temperature high enough to burn away the carbon, because carbon is a good conductor of electricity and when covering the end of the insulator will short-circuit the plug and cause missing This is the reason why there is a limit to the so-called "coolness" of a plug If a plug is so designed that it cannot hold enough heat to reach a temperature that will enable it to burn the carbon, it will give trouble from fouling It is for this reason that a racing plug, which is designed to take care of abnormal heat, will make a very poor showing in a commercial engine, where it will cause fouling trouble

If thermo-couples are set into a plug designed to receive them (Fig 2) in such a way that the temperature of the hottest part of the plug when the engine begins to pre-ignite can be read off, and the test is carried out with the various fuels on the market, the experiment will enable one to determine the temperatures which mark the limit of usefulness of the plug with the different fuels

Preferably the plug should always be hot enough to burn any carbon that may be formed, but not hot enough to cause pre-ignition Unfortunately the temperature range marked by these two limits is comparatively narrow—only about 350 deg C—which explains why plugs may easily cause trouble

By referring to Fig. 3 it can be seen that the heat absorbed by the plug at its inner end, passes from the end of the center wire through the tip of the insulator, the body of same, the seat gasket, the spark plug shell, and the plug gasket into the cylinder wall and the cooling water The threaded portion of the plug conducts only a negligible portion of the heat absorbed, and practically all of the heat must pass through the seat There are numerous factors which tend to cause the temperature of the plug to cary, these including: *Engine revolutions per minute, load on engine, cooling water temperature; engine temperature, kind of fuel; spark advance, air fuel ratio, air humidity; temperature of air around plug, draft around exposed part of plug*

Considering the difference in engine revolutions per minute by using either cruising speed or top speed it is easy to see that the same plug cannot at the best be used in both cases

Fig 4 shows plugs of different designs, with paths of heat flow of different lengths, and illustrates how, by varying the resistance to heat flow, especially in the insulator, the working temperature of the plug can be controlled

To meet aviation requirements the AC Spark Plug Co , besides the aviation line already in the market for many years, has developed a set of plugs shown in Fig 4 With this set of plugs it is possible to take care of any aviation engine now in the market This line of plugs is so designed that each member of it will, under given engine conditions, keep slightly cooler than the one which follows. Each plug is identified by a number and the higher the number the better the plug is adapted for use in a cool engine

The "Cabinaire" Biplane

Four Place Cabin Craft Produced by Paramount Aircraft Corp. Is Designed Around the Warner "Scarab" Engine

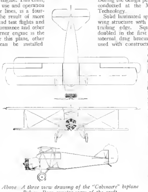
THE "Cabinaire" biplane, which is now being produced by the Paramount Aircraft Corp., Saginaw, Mich., is one of the first airplanes to be designed around the Warner "Scarab" engine. This craft, which is intended for private use and operation over mail and express feeder lines, is a four-place, cabin biplane It is the result of more than a year of development and test flights and has given proof of high performance and other qualities Although the Warner engine is the standardized power plant for this plane, other engines up to 200 hp can be installed

With the Warner engine, which develops 110 hp at 1850 r.p.m., the Cabinaire has a high speed of 103 m.p.h., a cruising speed of 90 m.p.h. and a stalling speed of 38 m.p.h. The rate of climb at sea level is 750 ft per min and the service ceiling 12,000 ft The plane as an upper wing span of 34 ft. 8 in., a lower wing span of 29 ft., an overall length of 23 ft and a height of 9 ft The weight empty is 1,300 lb and the total weight loaded 2,208 lb.

In general design the "Cabinaire" is representative of the single bay cabin biplanes which have found increasing favor during the past year The lower wing panels are attached at the lower fuselage longerons and the upper wing, which is in two panels, without a center section, is attached by cabane struts to the fuselage The usual "N" type interplane struts with external bracing wires are employed During the design period wind tunnel tests were conducted at the Massachusetts Institute of Technology.

Solid laminated spruce spars are used in the wing structure with web ribs and a duralumin trailing edge. Square Hartshorn tie rods, doubled in the first bay, are employed in the internal drag bracing Balanced ailerons are used with construction similar to that of the wings The wing is covered with Flightex fabric and doped Wiring for landing and navigation lights is provided. The airfoil section is original and produces a good combination of rapid take-off and low landing speed In tests the plane has taken off fully loaded in 150 ft and landed with the use of brakes in 50 ft.

Conventional welded steel tubing and fabric covering is employed in the fuselage construction with a special finish which produces a high luster and extreme smoothness All welding of the fuselage structure is done in jigs to prevent twist, contraction, or loss of alignment at any point on the fuselage Openings in the welding are sealed to prevent internal oxidation In order to prevent weakening of members, no drilling whatever is done on the fuselage structure The tail surfaces also are built of the same materials and adequate external bracing is provided The detachable engine mounting also is built of welded steel tubing and aluminum cowling of 0.040 weight is employed A firewall containing sealed felt pads prevents smoke or engine odors from passing through to the cabin.



Above A three view drawing of the "Cabinaire" biplane Below Rear quarter view of the craft

The roomy cabin presents a clean interior appearance and nothing but the nickel plated control stick, and two sets of pedals and the instruments are visible An indirectly lighted consolidated instrument panel containing altimeter, tachometer, oil pressure and oil temperature gauges, is provided Two wicker chairs are installed in the forward portion of the cabin and a full width wicker settee is placed in the rear Behind the settee is a baggage compartment of ample capacity Window moulding and dash board sets are of mahogany and a mohair rug is furnished for the floor Doors are provided on both sides of the cabin Special attention has been paid to visibility The windows in front are glazed with Pittsburgh Security Non Shatterable glass and Triplex is used in the side windows

Dual control is provided with a single control stick and the patented brake control consists of two small levers mounted on the control stick A slight pressure on either or both of these levers actuates the Bendix brakes The advantages of this arrangement are that the brake control is not in the way at any time but easily accessible when needed and the feet are left free to manipulate the rudder A control for the stabilizer adjusting mechanism is also located near the pilot's seat Push-pull tubes are used through the control system with the exception of the rudder cables which lead directly aft

All connections between the plane and the power plant, including the throttle rod, are fitted with vibration joints. Gasoline tanks, manufactured by the Paramount Tank Co., and installed in each of the upper wing panels, have a combined capacity of 42 gal and give the plane a cruising range of 465 mi. Tanks may be taken out for inspection by the removal of two turnbuckles Fuel is fed by gravity through ⅜ in copper tubing to the engine by way of a selective Lunkenheimer valve which permits use of the tanks separately or together. The oil capacity is four gallons An exhaust ring located behind the engine is connected to a combination muffler and cabin heater A Standard Steel propeller is furnished as regular equipment and a self starter is optional.

The landing gear, which is of the split type, is sturdy and has a tread of 7 ft 6 in The axle is located 21 in. ahead of the center of gravity. Standard equipment includes Aerol shock absorber struts 28 x 4 Bendix wheels and brakes with 30 x 5 tires All hinge connections of the undercarriage at the fuselage are designed to provide a means of substituting pontoons A spring tail skid is provided with a replaceable manganese steel shoe.

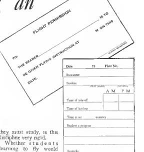
The manufacturer's specifications are as follows

Span, upper wing	34 ft 8 in
Span, lower wing	29 ft.
Total wing area, including ailerons	322 sq. ft
Height	9 ft
Length	23 ft. 9 in.
Landing gear tread	7 ft 6 in.
Weight empty	1300 lb
Total weight loaded	2208 lb
Gasoline capacity	42 gal
Oil capacity	4 gal.
High speed	103 m.p.h.
Cruising speed	90 m.p.h.
Landing speed	38 m.p.h.
Rate of climb at sea level	750 ft per min.
Service ceiling	12,000 ft
Cruising range	465 mi

Interior photographs of Paramount plant. Top Wings being built in the wood working department Center A completed "Cabinaire" fuselage structure Bottom Welders at work building up a fuselage.

Systematizing *an* Aviation School

By Charles E. Planck



FLIGHT PERMISSION

TO:

THE BEARER ______ IS TO

BE GIVEN FLYING INSTRUCTION AT ______ M ON THIS

DATE.

Date	19	Plane No.
Instructor		
Student		
	A M	P M
Time of take-off		
Time of landing		
Time in air	minutes	
Student's progress		
Remarks		

STUDENT PROGRESS CARD
The Embry-Riddle Flying School

THROUGH three years of operation in the flying school business, the Embry-Riddle Co , Lunken Airport, Cincinnati, O , has realized the imperative need of a rigid system of instruction both in ground school and flying school Without such a system the school easily slips into the haphazard, and the airport gathers a crowd of loafers, most of them unable to take training, but willing to sit for hours and watch planes fly

In planning the system which now obtains in the school, Robert L Rockwell, Major Air Reserve, formerly in the Lafayette Escadrille, the head of the school, and Walter H Cunyus, chief ground school instructor, considered one important matter first

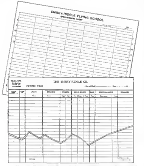
This concerns the willingness of the student to apply himself and assimilate the lessons in ground school and in actual flying instruction Sometimes the discipline necessary with large groups of students approaches that necessary in a military school Particularly in ground school classes, where for six weeks, five nights a week, they must study, is this discipline very rigid.

Whether students learning to fly would voluntarily accept such restrictions was a question, but it was found that most of the class were so intent on preparing themselves for a career in aviation that they were willing to study and study hard The length and scope of this course is indicated by the following outline of the first course of 1929 Lecture—(1) Jan 7, Department of Commerce rules and regulations; (2) Jan. 8, Aeronautical Nomenclature, (3) Jan 9, Aerodynamics—resistance, shapes; (4) Jan 10, Aerodynamics—lift, airfoil, design; (5) Jan 11, Aerodynamics—complete airplane, (6) Jan 14, Aerodynamics—stability, (7) Jan 15, Aerodynamics—performance, (8) Jan 16, Aerodynamics—stresses, practical flying; (9) Jan. 17, Airplane Construction—materials, (10) Jan 18, Airplane Construction—fuselage, wings, etc ; (11) Jan 21, Airplane Construction—controls, (12) Jan 22, Airplane Construction—dope and fabrics, (13) Jan 23, Airplane Construction—wires and cables, (14) Jan. 24, Airplane Construction—rigging, general repair, (15) Jan 25, Propellers, (16) Jan 28, Review and Examination; (17) Jan 29, Power Plant—theory, (18) Jan 30, Power Plant—theory; (19) Jan 31, Power Plant—parts, (20) Feb 1, Power Plant—valves; (21) Feb 4, Power Plant—carburetors; (22) Feb 5, Power Plant—lubrication and oil; (23) Feb 6, Power Plant—ignition, (24) Feb 7, Power Plant—ignition, (25) Feb 8, Power Plant—water cooled engines (OX-5), (26) Feb 11, Power Plant—air-cooled engines (Wright, Velie and P. & W); (27) Feb. 12, Power Plant—installation and inspection, etc ; (28) Feb 13, Meteorology, (29) Feb 14, Navigation; (30) Feb 15, Aerial Photography and Mapping, (31) Feb 18, Review and Examination; (32) Feb 19, Examination.

Lessons are assigned and printed copies distributed the night before, and are discussed and developed during the class period Each lesson averages ten pages of single spaced typewritten material, and one or more pages of illustrations Following each lesson are printed about a dozen questions, conveniently arranged to facilitate review Mr Cunyus holds a short review at the beginning of each lesson on the important features of preceding lessons, and at the close of the course a general review

An instructor explaining a few points to a student before going aloft Upper right corner The front and back of a student progress card.

After successfully passing this course a student can pass the "paper" examination for a transport pilot's license Illustrations of each lesson, while they are included on one or two pages of the lesson itself, are produced on the blackboard during the lesson study They are still available for study after the lesson is completed, on the written lesson sheets A room for ground school seating 75 is used, and classes begin nightly at 7 30 The above schedule was for the first 1929 ground course



EMBRY-RIDDLE FLYING SCHOOL
APPOINTMENT SHEET

THE EMBRY-RIDDLE CO.
FLYING TIME

Above Reproduction of the appointment sheet used by Embry-Riddle, and a log sheet for recording daily flying time of all planes Below A student about to be sent solo by the instructor

For flying instruction a second rigid program is maintained The school department, co-operating with the operations department, makes the best use of planes available, and every action of the student is watched, while he is getting in his solo time The overseeing is done by an "alert" pilot who sits in the operations office on the second floor of the office building, and who reports to the school department any eccentricities of the soloing student which need correcting

A lineman receives the planes each morning from the hangar after they have been inspected and checked by mechanics The student and his instructor are assigned to specific planes by cards issued from the head of the school or school secretary for dual instruction training This card must be presented to the lineman before the plane is released The lineman then records the time of take-off and landing of each plane, naming instructor and student, or student in case of solo flying.

The lineman is responsible for knowledge of the whereabouts of all planes under his control He checks frequently on all planes on the line and reports any that are unduly absent from the field He also reports flying of any character on the part of any solo student not permitted by school rules, as well as infractions of airport and flying rules by any instructor

His vigilance, together with the watchfulness of the "alert" pilot in operations office, prevents any risky flying on the part of "cocky" students A school rule requires that students gaining solo time fly within gliding distance of the field and only over the large flat fields of the Little Miami valley stretching many miles east of the field

The school policy is to check every solo student every two hours for the first 20 hr, and subsequently every five hours This checking is made more frequent at the suggestion of the "alert" pilot, who frequently is assigned to this job Instructors are regular air mail pilots employed on the C A M Route 24 operated by the Company.

OX-5 powered Waco training planes are used. Because of the possession of a large number of new engines of this type, and the standardized system of equipment, together with the low original and upkeep cost, the school is able to keep its instruction financially within reach of a great number of students Several engines are kept ahead, overhauled and ready for installation in training planes There is never any delay in this respect Engines are overhauled every 100 hr

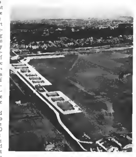
An extra ignition switch in the front cockpit and removable control sticks are being installed in all instruc-

tion planes. These two features give the pilot complete control of the plane at all times, and he is not required to depend on the immature judgment of a new student in emergencies that might result in crashes. The removable stick is of the type that is operated from the front cockpit by means of a wire, which, when pulled, entirely disconnects the stick in the pilot's or student's cockpit. The switch is considered valuable in taxiing where the instructor is sometimes at the mercy of a green student.

The operations department has estimated that one plane in the winter time can take care of the instruction needs of five students. During summer flying one plane will take care of 15 students. The difference results from the added maintenance difficulties in water cooled engines in cold weather and the much longer "flying hour" day that results in summer, the latter reason accounting for most of the difference.

A night maintenance crew at the hangars is working throughout the summer, and a plane incapacitated on the afternoon of one instruction day is ready for the air the next morning. This method facilitates service, and prevents delays in instruction programs. The longest and most complete course offered in the school is the 200 hr. course which turns out a transport pilot. For the pilot who desires to cut his training period down to a minimum this is the course advised by the school heads. Upon graduation the pilot is capable of handling any type of plane and qualified to fly passengers or express anywhere. In this course the usual training of the advanced course is supplemented with a long transition period, with flying time on a great variety of plane types.

Heads of the school, and school representatives who meet prospective students are instructed to emphasize the 50 hr. or "advanced" course. The company has realized the imperative need of pilots, and is constantly on the lookout among its students for likely material for its own pilot force.


Lunken Airport as it will appear in the future

The advanced course turns out a student capable of passing the examination for a limited commercial pilot's license, experienced in flying several types of planes, cross-country, aerial navigation, and maintenance. The last five hours with each advanced student is spent in transition work, with instruction in handling Whirlwind powered Wacos, Monocoupes, Fairchilds and Flamingos. Where students show unusual aptitude, this transition period is extended to 10 hr. Beginning in the summer of 1929, a Hisso Waco 10 fitted with pontoons will be used on the Ohio River, 200 yd. from the field, for training in this type.

Aerial navigation problems are worked out for each student of the advanced course by Major Rockwell, who checks every student in the school. These usually consist of a triangular cross-country flight with the instructor as a passenger. Wingovers, spins and stalls are taught every student, primary or advanced, and advanced students are required to become proficient in these maneuvers before graduation. Certain planes are specified for this type of flying, and are especially inspected by the lineman and hangar mechanics to insure absolute safety.

Getting prospects and signing up students in the flying school is taking on a new salesmanship aspect.

"Give them one chance. If they are interested, and the right type, urge them on. If not, drop them because there are lots more waiting" is a motto of one of the student representatives, and this practice generally is followed in the school.

Thus far, it has not been necessary to sell the courses with any intensive sales psychology or so-called "high-pressure" methods. The school has not maintained a downtown sales office, and has depended almost entirely on indirect contacts to supply prospects.

Among these indirect contacts are a house organ, "Embry-Riddle Sky Traffic," sent to prospective users of the company's services, responses to educational programs over station WLW every Saturday night at 7:30, advertisements in national trade magazines, classified advertisements in local newspapers, exhibitions of planes at automobile, food, and industrial shows, a special school exhibit at the Detroit Aircraft Show, activities of a speakers' bureau and the Sunday pleasure-riding crowds.

In the case of every prospect, the first effort has been to get him to the airport. This indicates his active interest, and conserves the time of the school representative, who is a busy enough man anyhow. Once the student has admitted interest and a desire to learn to fly, the representative confers with him in an effort to determine the type of course best suited for the student.

Almost every applicant has a career in aviation in mind. "I want to be an air mail pilot" is a frequently repeated remark. The representative first advises the advanced 50 hr. course, according the policy of the company. If finances prevent following this plan, the primary course is suggested, and if finances are still inadequate, the interest of the applicant is retained and promoted by enrolling him in the ground school course.

Not infrequently, the ground school graduate obtains enough money to take the actual flying course, and the primary course graduate obtains enough money to finish his 50 hr. of solo, and graduate as a pilot. The student representative during the last three months of 1928 and January, 1929, averaged 100 letters a week, and 35 interviews at the field a week.

A plan for using students in the school as part time representatives of the school is now in operation. When the student has enrolled two students for the primary course, he is given an hour in the air in company planes for the first, and $15 cash for the second. Capitalizing on the acquaintances and friends of students has resulted in many additional enrollments.

The public relations department of the Company has worked out a careful system of publicity on each student. Stories are sent to his home town papers throughout the training period, telling of his progress. These stories usually are printed in full in local papers, and have been found to be effective in awakening further interest in that town.

Concerning *the* Burdens *and* Costs

By Edwin R. Douglas
Consulting Engineer

WE have seen that the distribution of overhead through a blanket percentage, or burden on bare cost, may lead to large errors; that results are more correct when overheads on materials, labor, selling and administration are handled separately, and that a still closer approximation is reached when departmental divisions and distributions of overhead are made.

The latter plan is reasonably simple and works very well when the character of the work going through each department is at all times substantially the same. This is likely to be the case in an airplane or engine factory, and the departmental plan will probably find wide application in these industries. It is not, however, fundamentally correct, and is likely to lead to considerable errors when figuring the unit costs of parts made by different processes, such as hand work vs. machine work, stampings vs. forgings, etc. This will be particularly true where, to get straight line production, machines and operations of different types are grouped in sequence in the same department. The overhead of the department includes the indirect operating expenses of all the machines and processes in it, but the operating expenses of a hot forging group, a stamping press, a work-bench, and a miller, for example, would be very different. Each of these would involve the direct labor of one man, but the ratio of operating expense to direct labor (the burden rate) for each might be about as follows:

Hot forging group, consisting of oil furnace, heavy press and drop hammer	*700 per cent on labor*
Milling machine	*200 per cent on labor*
Stamping press	*100 per cent. on labor*
Work bench	*20 per cent on labor*
Average	*255 per cent on labor*

Obviously it would not do to compare the costs of articles made by these different processes by adding a uniform departmental burden of 255 per cent. on each. For such comparisons the individual rates of the different processes (commonly called "machine rates") must be used. Particularly should estimates of costs and savings by new and different processes be based on individual machine rate burdens. These must estimate as correctly as possible the use made by each process of every service charged to the department, such as floor space, power, water, steam, light, supervision, clerical expense, repairs, depreciation, insurance, taxes, etc., and should not forget return on investment. Regarding this last item, there is no intent to re-open here the battle between the "interest" and the "no interest" groups. But when we are considering the investment of funds in some new and improved equipment for the purpose of reducing costs, we must consider whether the resulting economies will be sufficient to pay not only all the usual operating expenses, but an adequate return on the investment as well. If our accounting conscience permits us to include it as an element in burden, well and good; if not, we must still retain it somewhere in the chain from cost to profit.

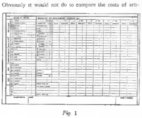


Fig 1

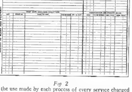


Fig 2

Thus far, we have spoken only of burdens being distributed at a percentage on labor, but if machine rates are to be used it will be more direct to set them simply as hourly rates for the use of the machines. This eliminates any variations arising from differing wage rates of the operators. For instance, the rates for the machines listed in a preceding paragraph might reasonably be:

Hot forging group	*$5.00 per hr.*
Milling machine	*1.50 per hr.*
Stamping press	*.50 per hr.*
Work bench	*.12 per hr.*

These figures are supposed to be the actual cost of op-

erating the different machines or processes, but since some of the elements, like depreciation, rental for floor space, etc., are based on fixed annual charges, the setting of the hourly rates involves an estimate as to the probable number of hours the machine will operate in a year. Two machines might be exactly similar in all respects and all requirements, but if one is to operate twice as many hours per year as the other, its rate will be lower. The following is a condensed example

	Machine No. 1	Machine No. 2
All fixed charges, per year	$1,200	$1,200
Divide by operating time of	2,400 hr.	1,200 hr.
(a) Gives fixed-charge element in machine rate, per hour	$ 50	$1 00
(b) Add hourly operating cost for power, supplies, repairs, supervision, etc. (same on both)	30	30
Total machine rate per average operating hour..	$ 80	$1 30

We shall presently recur to the two elements (a) and (b) above. While considerable careful work is involved in determining the machine rates for a large factory, it is not in any way an impracticable task if taken systematically. A sample of a form used in making such computations is shown in Fig. 1. It is known as a "Make-up of Equipment Charge" form and provides columns for refiguring the rates from time to time as basic costs and conditions change. On the back of this form is another, marked "Record of Plant and Property," for keeping a complete record of the purchase, cost, depreciation, etc. This is shown in Fig. 2.

Machine rates, at so much an operating hour, may be looked on as a kind of wages earned by the machines to pay for their upkeep, operation and supplies, just as the wages earned by the workmen are to pay their living expenses. These are credits to the men and the machines. In the case of the men, it is necessary to keep complete detailed payroll records, for workmen must receive their exact personal earnings. But machines care nothing about this, and, except for statistical purposes, there is no necessity for recording individual machine earnings.

From the cost side, however, the case is different. Where costs are built up from direct material, direct labor and departmental overheads, the latter will include allowances at averaged rates for the operating expenses of the machines. We have seen that, however well such averaged rates may work out in wholesale, they will not give correct results in detail, for the hourly rates of different sorts of machines vary too greatly. To obtain accurate costs on parts, machine rate burdens must be used. There is the same reason for charging each machine's earnings to a job that there is for charging each workman's earnings. Indeed, there is usually much more reason, for the machine rates on a job are usually higher than the workmen's rates, sometimes much higher, as seen in the examples above. Often, indeed, instead of figuring wages with great accuracy and adding burdens at rough averaged percentages, it would be more nearly correct to figure the burdens accurately, at machine rates times hours, and add the labor at averaged percentages. Does this seem ridiculous? It would be the more logical way wherever the burdens run over 100 per cent.

The meaning of this is plain. If it be necessary to carry on cost systems in which the labor costs are posted in detail to individual orders, then the machine burdens, at hourly machine rates, should be figured and posted to them in the same way. In such case each man-machine ticket must bear both of these rates and both extensions. Tickets must also be made for men working away from machines and for time machines are idle and not in operation. This is the logical and correct, if unusual, extension of the ordinary detailed cost system. It is, of course, very laborious; but it has been done, to the multiplication of clerical expense, extension of red-tape, and disrepute of cost accounting.

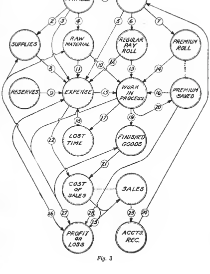


Fig. 3

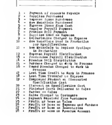


CHART OF ACCOUNTS

EXPLANATION OF TRANSACTIONS

1 - Payment of Accounts Payable
2 - Supplies Purchased
3 - Expense Items Purchased
4 - Raw Materials Purchased
5 - Expense Items from Cash
6 - Regular Payroll Payment
7 - Premium Roll Payment
8 - Supplies Used on Expense
9 - Depreciation Charged to Expense
10 - Raw Materials Used in Production per Specifications
11 - Raw Materials to Replace Spoilage in Production
12 - Expense Payroll Distribution
13 - Productive Payroll Distribution
14 - Premium Roll Distribution
15 - Burdens Charged to Work in Process
16 - Saved Premium Charged to Work in Process
17 - Lost Time Credit to Work in Process
18 - Lost Time Transfer to Expense
19 - Completed Product at Discounted Specification Cost
20 - Discount on Specification Cost
21 - Finished Goods Delivered to Sales
22 - Burden on Sales
23 - Sales Charged to Customers
24 - Payment Received from Customers
25 - Profit or Loss on Sales
26 - Profit or Loss on Expense and Burdens
27 - Profit or Loss on Inventories
28 - Profit or Loss on Premium Account

Fig. 4

It is the argument of this whole series of articles that in productive costs (and alike for materials, labor and burdens) such cost keeping methods are slow, laborious, inaccurate, expensive, wasteful and usually unnecessary. On the other hand, costs which can be based on well-made specifications are immediate, easy, accurate, and economical. This applies to the use of machine rate burdens as well as to direct labor and direct material.

Divergencies Should Be Made Known

In order that costs may be based on specifications, it is necessary either that the work be done exactly as specified or, where not, that the divergencies be made known at once and accounted for. Divergencies there always will be. It is the method of modern cost accounting wherever possible, to set up standards which can be and should be followed, to do no further clerical work on the cost of items which are in accordance with these standards, but to report all divergencies, as to their natures, amounts, and causes, and to concentrate attention on these divergencies. If investigation shows that the standards are wrong, they and the standard costs will at once be corrected, but if the divergencies are due to delays, losses, errors, or breakdowns, the costs of these will be charged, not to the jobs on which they happened to occur, but to accounts covering their causes and the departments responsible. These accounts are expense accounts and a part of the departmental overheads. They will enter into those overheads, or into the machine rates, and be distributed over and borne by all the jobs done by the departments and machines responsible for them. Through this channel they enter into the standard costs.

The amount of clerical labor required by this method will be less than that required for keeping the old-style detailed costs, particularly so if the latter involved machine-rate burdens. The clerical effort thus displaced may, for a time, be invested in the building up of the system of standards. Costs thus determined by standards, including correct burdens with allowances for average delays and losses, will be far more dependable than any offered by the older type detailed cost system.

The means required for these specification costs have all been discussed in earlier articles of this series. They include full specifications of material and labor, pre-written material tickets and labor tickets, and methods for scheduling and dispatching work. The methods for immediate reporting of divergencies are as follows.

The store room will give out no productive material

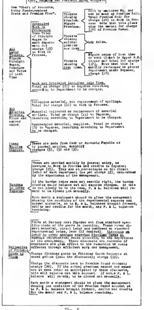


CHART OF ROUTINE
AFFECTING PAYROLL, EXPENSE, WORK IN PROCESS, PREMIUM AND FINISHED GOODS ACCOUNTS

See "Chart of Accounts, Using Predetermined Costs and Premium Plan".

All Labor Tickets. Figure Straight Wages, Premiums and Value of Lost Time
- Scheduled Work on Production. Take Total of Straight Wages in each department for charge (13) to Work in Process.
  - Tickets showing Premium. Figure Premiums. — Sort by employee No. and use to make up Premium Roll. Total Premium Roll for charge (14) to Work in Process. Note that this gives also the amount for charge (16) of Premium Saved.
  - Tickets showing neither premium nor loss — Lay Aside.
  - Tickets showing lost time. — Figure value of lost time on each ticket in Upper R.H. corner and total for charge (17). Note that this is monthly recharged to proper department under Expense, charge (18).
- Work not Scheduled Including Idle Time. Total as charge (12) to Expense reporting according to Department to be charged.

All Material Tickets. Price and extend value.
- Scheduled material, not replacement of spoilage. Total for charge (10) to Work in Process.
- Material delivered as replacement of material spoiled. Total as charge (11) to Expense, reporting according to Department to be charged.
- Unscheduled material, supplies. Total as charge (8) to Expense, reporting according to Department to be charged.

Other Expense Charges.
- These are made from Cash or Accounts Payable or by journal entries, monthly; charges (3), (5) and (9).

Burdens to cover Expense.
- These are carried monthly by journal entry, as charges to Work in Process and credits to Expense; charge (15). They are at percentages on the direct labor of each department (as per charge 13), determined by the experience of the management.
- If the burden rates were set exactly right, the burden credits would balance out all expense charges. As this is not likely to be the case, P. & L. balances will remain to be closed out annually.
- Each month a statement should be given the management showing the condition of the departmental expense and burden accounts, as to P. & L. balances brought forward, debits and credits for the month, and P. & L. balances remaining.

Delivering of Finished Goods to Stock
- Price at Factory cost figures set from standard specifications of the goods in question. These cover direct material, direct labor and overhead at standard departmental rates, less (if desired) Discounts on labor to cover average expected Premiums Saved at average departmental rates according to the experience of the management. These discounts are converse of overheads and give effect to the reduction in costs effected through efficient work and management.
- Charge finished goods to Finished Goods Accounts at above prices (less the discounts); charge (19).
- Charge the discounts back to Premium Saved Account; charge (20). If the actual premiums earned and saved are at same rates as anticipated by these discounts, this will balance out this account. If not, a P. & L. balance will remain, to be closed out annually.
- Each month a statement should be given the management showing the condition of the Premium Saved Account as to P. & L. balance brought forward, debits and credits for the month and P. & L. balance remaining.

Fig. 5

other than that on the standard specification, unless specially authorized by a spoilage ticket. These spoilage tickets are the immediate source of information as to divergencies in material

Labor tickets will be written in advance, in duplicate and on self-carbonized strips, and will show the standard time allowances on the jobs By the methods already described, these tickets, when turned in "complete," show the actual time taken, and the time saved or lost The duplicate copies, sorted by departments and into three groups, "time saved," "time lost," and "exact," give the basis for a daily check-up of time losses according to their causes The original copies serve first as means to compute and accumulate any premiums to be paid to workmen for time saved, and then as the basis of journal entries, weekly or monthly, accounting in total for time lost charges and time saved credits These accounting transactions and the routine involved are shown in Figs 3, 4 and 5

Only Five Transactions Unusual

Inspection will show that nearly all the transactions indicated on this chart of accounts shown in these figures are those of the usual industrial accounting system. The only unusual ones are Nos 16, 17, 18, 20, and 28, having to do with the time lost and time saved accounts. While these have been added as weekly or monthly postings, the entire structure of detailed order cost accounting is gone All that now remains of the old type cost system is the collection and distribution of overhead expense items and the checking of their totals with the burdens earned to cover them

This completes a description, in the briefest form, of what we have termed the modern way of cost determination and control We may now pass on to consider some phases of cost application resulting from the principles and methods which have been described

In an earlier paragraph a tabulation was presented comparing the machine rates on two similar machines, one of which was expected to operate more hours in a year than the other Two elements in their expense were shown, as follows

(a) Fixed expense, made up of factors whose total does not vary, no matter whether the shop is slack or busy

(b) Variable expense, consisting of factors whose total varies directly with the volume of work going through

The total expense of every plant, department and machine is made up of two elements like these. Of the first, executive salaries would be an example, of the second, a pure example is not so easy to find, though many expense items contain it along with the first.

Some very important matters depend on the relation between fixed and variable expense, and it is desirable to know how to determine that relation This is done by preparing an expense budget for each of several possible operating conditions, such as that of the plant working at 100 per cent capacity, and at several other smaller and larger capacities For each of these, estimate as nearly as possible the number of productive and non-productive men that would be required in each department and their wages. Estimate, also, each of the other items that go to make up expense. It will be found that some things will remain fixed for some parts of the range, but, at certain points, will jump suddenly to other fixed values Such would be supervisional salaries, jumping when it became necessary to add a foreman, assistant foreman, or assistant superintendent; or power, when another boiler or engine had to be brought into service. On the whole, however, there should be a fairly steady increase with increasing percentages in production. This may be illustrated by the table shown at the bottom of the page

A *Minimum Value of* $200,000

A graph of these values, with the curves prolonged backward to the ordinate for zero capacity, is shown in Fig. 6 It is seen that while the direct material and labor start from the value zero at 0 per cent. of capacity, the total expense and so the total cost start from a minimum value of $200,000 This minimum may be considered as the fixed element in expense and cost, while the amount by which the actual expense rises above this minimum may be considered as its variable element, and therefore as one variable element in total cost The other variable cost elements are direct material and labor.

It is also seen that when, for these particular conditions, the volume of production falls appreciably below 75 per cent of normal, profits disappear and losses result The remedy for this lies in (a) cost reduction, (b) increased sales effort, and (c) lower selling prices to stimulate sales At this point we are concerned only with the last one of the three. That is, how far are we justified in reducing prices to keep the plant running in a dull season?

"Hidden Profits" Reduce Burdens

It is sometimes said that prices reduced even to the point of showing individual losses still carry a "hidden profit," meaning that they help to absorb some of the fixed overhead, and so to reduce the burden on other work The fixed overhead must be carried anyway, orders or no orders Like death and taxes, it is always with us. If there is not busines enough to carry it, it will show up at the end of the year as a loss In a slack condition of business, any additional orders that can be obtained over the otherwise minimum, at prices to cover their direct material and labor and the variable element in their overhead, are just paying their way Anything above this becomes an additional contribution toward paying the total fixed overhead, and so reduces the loss at the end of the year This may be illustrated by the following example:

Per Cent of Capacity		Direct Material	Direct Wages	Total Overhead Expense	Total Cost	Sales at Fixed Prices		Loss Profit
(a)	25	$50000	$75,000	$275,000	$400 000	$250,000	L.	$150 000
(b)	50	100 000	140 000	340 000	580,000	500,000	L.	80,000
(c)	75	150 000	200,000	390,000	740,000	750,000	P.	10,000
(d)	100	200,000	250,000	420,000	870,000	1,000 000	P.	130,000
(e)	125	250,000	340 000	460 000	1,050,000	1,250,000	P.	200 000
(f)	150	300,000	470,000	530,000	1,300,000	1,500,000	P.	200 000

In the tabulation of productions and costs given above, condition (b), 50 per cent normal production, shows a loss of $80,00 at the end of the year, all sales beig held to full normal prices Under this condition the sales are but $500,000 and the cost of them is $580,000 The variable element in this cost is less than this by $200,000 (the fixed expense), or is but $380,000 which is 76 per cent of the sales If, under these conditions, additional business

can be obtained at any price above 76 per cent of normal, then, according to what has just been said, it will reduce the $80,000 loss at the end of the year Suppose that a 20 per cent reduction or extra discount will bring in 10 per cent more business, amounting at the reduced price, to $40,000 increased sales Since all the $200,000 fixed expense has already been covered by the $580 000 cost of the business already in hand, this new business can be manufactured for its variable expense alone, or for 76 per cent of its full price cost—that is, for only $38,000 additional cost This gives a profit, all clean, of $2,000 on this additional business, and reduces the loss of the year by that amount These results may be tabulated as follows

	Maximum Sales at Full Normal Prices, same as Condition (b)	10 per cent additional business obtained at 20 per cent lower prices or 8 per cent additional sales	Net Result
Sales	$500 000	$40,000	$540 000
Cost	580,000	38,000	618 000
Loss	$80 000		
Gain		2,000	
Net Loss reduced by reason of increased business			$78,000

This course of action though taken at an apparent loss so far as old cost methods would show, would yet put in the treasury $2,000 more than if it had not been taken If the sales response to this offer were greater, or if the response could be obtained with a smaller offered discount, the resultant advantage would be greater, but in no case should the net price be lower than the variable element in the cost Rather, for safety, it should be at least a little higher Such action should not be taken except as an emergency measure, when the plant is not operating to capacity, and should be discontinued promptly as production comes up to normal Nor should it be opened for indiscriminate use by salesmen, but only used under control by the executive with a full understanding both of its theory and the facts The above illustration shows the importance of having an accurate analysis of overhead expense into its two elements, fixed and variable Under competitive conditions the result of the business-getting game may depend entirely on that knowledge

The old type detailed cost system or any system which burdens all business at similar rates without regard to the distinction between fixed and variable expense, would indicate, on such additional business, not a gain, but a loss proportionately even greater than that on the primary business obtained at normal rates To bring prominently to attention the facts regarding these distinctions, not only is a different method of expense accounting required, but, as indicated in an earlier paragraph, the allocation of expense must be made according to pre-arranged budgets

Methods Applicable to a Single Department

The methods indicated by the table and graph, covering the whole plant, are equally applicable to a single department or machine Each has its fixed and its variable expense, and for the application of these methods these elements must be determined It is, however, unnecessary to do this for so many businss conditions as were shown in the above table, and here is where the budgeting comes in

In a budget prepared in advance, we are furnished with an estimate of the amount of business to be expected and the expense of handling it It is for this particular condition, not for all possible ones, that the analysis of expense into fixed and variable is required This will, indeed, be called for in the preparation of the budget, and that is where the prires and amounts of business obtainable, and the elasticity and responsiveness of the market must be considered The budget will be worked out according to the best information and judgment obtainable to give the largest possible return or, in slack seasons, the smallest loss (and the desirability of carrying loyal and efficient members of an organization through a slack time, even though without profit, will not be lost sight of).

When such a budget of sales and costs has been prepared, it will indicate the distribution to be made of the different expense items Possibly some, which cannot economically be carried by production under existing conditions, will be indicated at the start as deferred items or losses Idle time of machines caused by unusual business conditions may fall in this category Then, until some considerable change in conditions calls for re-budgeting, the costs (predetermined) will follow these expense distributions If, under such circumstances, some unusual business must be handled, disregarding fixed expense for example, the handling of it is simple, for its estimates show directly how it was taken and how it is to be cared for If in its manufacture, there is any deviation from the methods and costs contemplated in the estimate, this will be at once brought to light, as described in a previous paragraph on divergencies The handling of this kind of business by the old detailed cost methods would have led to almost inextricable confusion and could not have been carried through

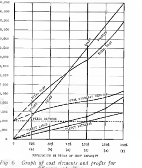


Fig 6 Graph of cost elements and profits for different capacities

Although the subject is far from exhausted, we will bring this discussion of it to a close at this point, with the comment that the modern methods which have been described, although not complicated nor laborious—less so, in fact, than the older ones—must be controlled by talent somewhat broader than was usual with the older systems There is more need for intelligent understanding of the aims and methods, for interpretation of the results, for co-operation with the engineering, stores and producing departments, and above all for thorough understanding and co-operation between the department in control of cost and production and the executives of the company And all of these must keep constantly in mind the principle with which this series of articles opened That is, that at the foundation of all successful modern management is exact, centralized knowledge of what, how, where, and when

Wright Company Establishing Chain of 36 Service Depots

Manufacture, Sale and Servicing of Engines Also Arranged in Foreign Nations

PATERSON, N J—The establishment of 36 depots in all parts of the United States for the repair and servicing of Whirlwind and Cyclone engines is announced by the Wright Aeronautical Corp This the company calls the most extensive arrangement yet made by any manufacturer in the aviation industry for the convenience of airplane owners In addition to the American service stations and parts dealers, the Wright organization has concluded arrangements for the manufacture, sale and servicing of its engines in five foreign countries.

The list of 36 depots falls into two divisions There are 11 firms in widely separated regions authorized to sell spare parts and perform complete engine overhauls At their stations a complete list of spare engine parts will be stocked at all times, together with full machine equipment in exact duplicate of that used at the manufacturing plant Price lists for repair work will be identical with those established for factory overhaul

The 11 authorized parts dealers are Air Associates, Inc., Curtiss Field, N Y, H. C Barru, Mexico City, Mexico, East Coast Aircraft Sales Corp, Boston, Ludington Flying Service, Philadelphia, Pacific Aeromotive Corp, Los Angeles Robertson Aircraft Corp, St Louis, Mo, Servair, Inc, Pittsburgh, Stout Air Services, Detroit, Texas Aeromotive Corp, Fort Worth, Watkins Manufacturing Co, Wichita, Kan, and Thompson Aeronautical Corp, Cleveland

Stations Named

The 26 service stations, operating under contract with either the Wright company or an authorized parts dealer, are Braniff, Inc Oklahoma City, Bredouw-Hilliard Co, Kansas City, Embry-Riddle Company, Cincinnati, Flyers, Inc, Albany, N Y General Aviation Co, Syracuse Jack Byrne, Inc, Grand Rapids, Johnson Flying Service, Dayton, O, Midwest Airways, Inc, Milwaukee Pitcairn Aviation Co., Richmond, Va., Wright Aeronautical Corp, Service Division, Paterson, N J, Robert Fogg, Concord, N H, Pacific Aeromotive Corp, Oakland, Calif, Van Nuys Airport Los Angeles, Thompson Aeronautical Corp, Bay City and Kalamazoo, Mich, Wright & Eisenwein, Buffalo, and the Texas Aeromotive Corp at the following points Big Spring, Tex., Brownsville, Tex, Dallas, El Paso, Houston, San Antonio, Texarkana, Ark, Birmingham, Ala., Mobile, Ala, New Orleans, La., and Atlanta, Ga

Foreign licenses have been granted to Canadian Wright, Ltd, Montreal, Government of Poland Warsaw, Mitsui & Co, Tokio; Skoda Works, Ltd, Prague, Czechoslovakia, and Societe Francaise Hispano Suiza, Paris

According to Bruce G Leighton, Director of Sales and Service for the Wright company, more than 100 service stations will be in operation before the end of the year

"It is our aim," said Mr. Leighton, "to have a complete plant for the care of Whirlwind and Cyclone engines within easy reach of every owner We shall require of all authorized parts dealers that they keep on hand an absolutely complete stock of spares—from cotter pins to cylinder barrels and crank cases And thus we shall go quickly away from that situation in which an airplane owner found his ship useless, and far from help, with no more serious a defect than the loss of a small bolt or the wearing out of some common working part"

Vought Planes Rushed For Mexican Warfare

LONG ISLAND CITY, N Y — A double working schedule has lately been followed by the Chance Vought Corp, this city, in order to quickly turn out a fleet of attack planes for the Federalists in Mexico now engaged in warfare with revolutionists Col. Samuel C. Rojas, military attache of the Mexican embassy, Lieut Paul Azcarte, and Lieutenant Rodolfo are now hurrying their training in the flying of these craft, and six other Mexican pilots will shortly follow in their steps preparatory to fighting in the air for the Federalists

Contracts for delivery of a number of Corsair naval observation planes to the governments of Cuba, Argentina, Mexico and Peru were recently announced by the Chance Vought firm, apart from the above rush order for Mexico occasioned by revolutionary warfare

Name Air Defense Committee

WASHINGTON D C—In pursuance of Senate Joint Resolution 11, a joint committee of five Senators and five Representatives has been named to investigate the problem of control of aircraft for seacoast defense The committee follows Senators Bingham, Hale, Fletcher, Swanson, and Reed (of Pennsylvania) and Messrs Taber of New York, Ransley of Pennsylvania, Evans of California, Lee of California, and Boylan of New York.

Large Swallow Contract Placed

WICHITA, KAN —While in this city recently, J E Granger, Pacific Coast Swallow plane distributor operating at Santa Monica, Calif, placed an order for 50 Swallows costing in total approximately $175,000 All are to be delivered during 1929 Mr. Granger, who last year was the firm's leading distributor, has a territory which includes Washington, Nevada, California, Oregon, New Mexico, Lower California and the Hawaiian Islands. Twelve representatives are under Mr Granger in this territory, and more are to be appointed this Spring

Type Certificates Issued

WASHINGTON, D C—New approved type certificates for planes are announced as follows No. 111 Travel Air, SC 2000, three place open land biplane, Curtiss Challenger, No. 112 Travel Air W 4000 three place open land biplane, Scarab, No 113 Mono-Aircraft Monocoupe two place closed land monoplane Velie 55

Pittsburgh Aero Show Proves Big Attraction

PITTSBURGH PA—As AVIATION goes to press, the first local annual aircraft show, scheduled for March 9 to 16, is well under way Crowds have been thronging the Motor Square Garden every day and the display has aroused considerable interest throughout the whole Pittsburgh district

On account of inclement weather, nine planes were absent from their exhibition spaces when the show opened Five of these were held at Bettis Field until they could be brought to the hall The others were expected to arrive early in the week

Among the well known pilots attending are William S Brock, Edward F Schlee, George W. Haldeman, Parker D Cramer, William J Scripps, Eddie Stinson and Eddie Rickenbacker Others are expected Lieut Leigh Wade was expected at Bettis Field in the Chapman-Burnelli air liner

It has been announced at the show that the American Aircraft Corp, an exhibitor here, has taken over manufacture of the Zenith airplane designed by M R Ruble and recently tested by Bettis Field mail pilots Production at the local plant is to be increased, it is said

Sunday was called Noted Pilots' Day, featuring the famous fliers present at the display Other special days include Disabled Veterans' Day, Army and Navy Night, Chamber of Commerce Day and Civic Organizations Night

Mexican Embargo Resumed

WASHINGTON, D C—Because of the present trouble in Mexico the State Department has again placed an embargo on the shipment of commercial aircraft to that country

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Universal Plans 11 Aero Schools

Leading Cities Named as Bases in Instructional Chain To Be Formed

CHICAGO, ILL—Under the general activities of Universal Aviation Corp, which now extend into almost every branch of aviation activity, shortly will be listed a most comprehensive chain of schools, according to plans announced. The three school divisions—Robertson in St Louis, Mid-Plane in Minneapolis and Egyptian in Marion, Ill—will be increased to 11 This total, before the end of the year, will be even greater, according to Comdr. Willis B Haviland, general director of schools.

A new school will open in Kansas City where hangars now are being constructed, and additional schools will be opened in Chicago, Cleveland, Mexico City, Omaha, Tulsa, Dallas, and Cincinnati

Six Irving parachutes have been ordered for the course in aerobatics and advanced flying, and others may be ordered from time to time As soon as they arrive, all students and instructors will be equipped with parachutes on each flight.

In addition, several Whirlwind engines have been ordered and negotiations are under way for a number of Pratt & Whitney engines to care for the increased scope of the schools Plans also are under way for the purchase of new planes

The new night school for mechanics in St Louis opened March 5 with 21 students

Show for Oklahoma City

OKLAHOMA CITY, OKLA.—Members of the local chamber of commerce aviation committee are making plans for the first annual Oklahoma City air exposition which will be held sometime in May The committee, of which Thomas R McHenry is chairman, includes Sherman Lohman, B S Graham, C R Anthon, Ray Dawson, W A. Kitchen, Cy Fentris, J R Green, Burrell Tibbs, and Paul Braniff

Research Conference May 14

LANGLEY FIELD, VA.—The Fourth Annual Aircraft Engineering Research Conference of executives and engineers of the aircraft industry and N A C A. representatives is scheduled to be held here May 14 The primary purpose of the meeting is to ascertain through discussion the various points of view regarding technical problems of aircraft design and construction

Secure Interest in Stromberg

NEW YORK, N Y—According to reports, holdings in the Stromberg Carburetor Co have been acquired by Richard F Hoyt, C. M Keys, and Vincent Bendix These men, it is said, have taken positions on the board

Carries Letters to Eaker

WASHINGTON, D C—Capt Ross G Hoyt, Air Corps, recently completed a round trip flight between Bolling Field here, and Kelly Field San Antonio, Tex. in the fast time of 37 hr 35 min. The actual flying time for the 3100 mi was but 25 hr 45 min, it is reported Captain Ross carried official correspondence to Capt. Ira C Eaker to be transported in turn by the latter in his planned dawn-to-dusk flight to the Canal Zone, which has, incidentally, been postponed indefinitely because of recent Mexican revolutionary disturbances

Status of Federal Air Positions Announced

WASHINGTON, D C—During the week the fog surrounding the impending appointments and resignations in Government aviation positions has begun to clear Edward P Warner, it has been announced, will be succeeded as Assistant Secretary of the Navy for aviation by Davis S Ingalls of Cleveland, O, F Trubee Davison, on the other hand, is to be retained in his present position as Assistant Secretary of War for aviation

William P MacCracken, Jr Assistant Secretary of the Department of Commerce for aviation will soon leave his position, according to Secretary Lamont "While several names are said to be tentatively under consideration, no selection is expected at the present time" Secretary Lamont announced. Rear Adm William A. Moffett, chief of Naval Aviation will, it is indicated, be reappointed to another term in his present post by President Hoover

Mr Ingalls has won the Navy Distinguished Service Medal and Navy Cross for bravery as a pilot in the World War He also received the Distinguished Flying Cross from the British Air Ministry for his Service with the Royal Air Force, with which he was also associated for a time

Eielson Gets Harmon Trophy

WASHINGTON, D C.—The Harmon Trophy for 1928 was awarded here March 9 to Carl Ben Eielson for his participation in the trans-Arctic flight with Capt Sir George Hubert Wilkins. Medals of honor were awarded to four Americans and one foreigner, these being the late Charles B D Collyer, Wilmer L. Stultz Arthur Goebel, Thomas Carroll, N A. A. test pilot, and Captain Wilkins The Harmon Trophy is awarded for individual accomplishment in demonstrating the use of the airplane for transportation These distinctions were voted in Paris recently at a meeting of the International League of Aviators

Preparing Ta-Ho-Ma

CHICAGO, ILL.—Report is issued by J N Janes, advertising manager of the Ta Ho-Ma Airplane & Motor Corp this city, that the firm's three place biplane is going along nicely at the Elgin, Ill, factory, and that it will be ready for display in the Buffalo Air Show B H Vanderveld is president of the organization, while M D Gardner is general factory manager

Gates Will Make Belgian Airplane

Craft Designated as "R.S.V." Is Unique Convertible "Bi-Monoplane"

NEW YORK, N Y—Plans have been completed for the manufacture in this country of the Belgian R S V convertible biplane-monoplane, it was announced by Ivan R Gates, president of the Gates Aircraft Corp, whose firm will immediately begin production of the small planes at a plant located in Long Island

This will be the first time the Belgian plane will be built outside of that country. Negotiations for the American rights were completed last week by Captain Gates and Francis Van der Ghote, managing director of J Stampe & M Vertongen of Antwerp, owners of the patents for the plane. Mr Van der Ghote has returned to Europe.

There will be certain changes in the structure of the R. S V to conform with American aviation standards it was announced by Captain Gates The present wooden fuselage will be replaced by one of steel and the weight and size will also be slightly altered

Folding Wings Proposed

The outstanding feature of the R S V. is its convertible wings, which will permit the transformation of the plane from a biplane to a monoplane As a monoplane it can develop a speed of 115 m p h. The conversion from mono to biplane can be made through the wing changes within two hours. It is proposed by Captain Gates to make both sets of wings of the folding type so that the plane can be pushed into a garage

The first Belgian R S V to visit this country will arrive on March 16 on the liner *Pennland* to be shown at the aviation show in Detroit It is expected that Captain Von der Linden, Belgian war ace, will accompany the plane to this country

Record Claimed For Davis Plane

INDIANAPOLIS, IND. — A new record for a plane powered with a 60 hp. engine is claimed for the Davis monoplane, this craft having been flown on March 7 from Richmond, Ind, to Pittsburgh, Pa., in the fast time of 106 32 m.p.h. The distance is 280 mi.

Lieut. Pat Love, general superintendent of the Davis Aircraft Corp., was piloting the LeBlond powered monoplane to Pittsburgh for the air show. He carried 12 doz roses from the Joseph H. Hill Co, Richmond, to Mayor William Kline of Pittsburgh.

Large Finance Firm Organized

Lehman and Harriman Interests Back "The Aviation Corporation"

NEW YORK, N Y—Called one of the largest projects of its kind yet launched, organization of The Aviation Corporation is announced here. The company, which will be primarily a holding and development corporation for the aviation industry, will have an authorized capitalization of 10,000,000 shares of common stock with no senior securities authorized. Initial financing contemplated for the corporation is expected to provide $35,000,000 cash.

The aims of The Aviation Corporation include making available to its subsidiary and affiliated companies technical and management cooperations as well as financial resources beyond those which would be at the command of any single unit. While it is anticipated that the holdings of the corporation will consist largely of the majority of the common stocks of other companies, it may also acquire interests in companies not controlled, which companies may be established concerns or new organizations created for experimentation development, investment manufacture sales or operation of aircraft.

Stock to Be Offered

A banking group headed by Lehman Brothers and W. A. Harriman & Co., Inc. will it is understood, offer shortly at $20 a share 2,000,000 shares of common stock of the corporation.

The board of directors of The Aviation Corporation as announced in preliminary form, includes a particularly strong representation of prominent railroad and steamship executives. The officers of the corporation will include W A Harriman as chairman of the board of directors, Graham B Grosvenor as president, Robert Lehman as chairman of the executive committee, and George R Hann as vice-chairman of the executive committee.

Officials of transportation companies who are to be members of the board of the new corporation are L. W. Baldwin, president, Missouri Pacific Railroad Co.; Matthew C Brush, director of several large railroad companies; R. Stanley Dollar, vice president, Dollar Steamship Line; Edward P. Farley, chairman of the executive committee, American Hawaiian Steamship Co.; John M Franklin, vice president, Roosevelt Steamship Co. Inc.; John L. Lancaster, president, The Texas & Pacific Railway Co.; J S Pyeatt, president, Denver & Rio Grande Western Railroad Co.; C. B Seger, chairman, finance committee, Union Pacific Railroad Co.

The other directors, in addition to the officers of the company, will include Frank Andrews, Andrews, Streetman, Logue & Mobley, Houston, Tex.; Harold O Barker, Jessup & Lamont; William G Beckers, director, Allied Chemical & Dye Corp.; C. K Boettcher, Boettcher & Co., Denver; D K E. Bruce, W A. Harriman & Co., Inc.; Rogers Caldwell, Caldwell & Company, Nashville; Frederic G Coburn, Sanderson & Porter, New York; W W Crocker, vice president, Crocker First National Bank of San Francisco; John W Cutler, Edward B Smith & Co.; Sherman M. Fairchild, president, Fairchild Aviation Corp.; John C. Grier, Jr., president, Guardian Detroit Co.; Stanley J Halle, Halle & Stieglitz, New York; John W Hanes, Chas D Barney & Co.; George M Holley, president, Holley Carburetor Co., Detroit; A. L. Humphrey, president, The Westinghouse Air Brake Co.; James M Hutton, Jr., W E. Hutton & Co., Cincinnati; W F. Kenny, president, Wm. F Kenny Co., New York; Robert Law, Barnsdall Corp.; William Dewey Loucks, Loucks, Griffin, Connel & Cullen, New York; Alan J. Lowrey, vice president and manager, Crocker First Co., San Francisco; C. Townsend Ludington, president, Ludington Philadelphia Flying Service Inc.; Paul M. Mazur, Lehman Brothers; George Mixter, vice president, division of aeronautics, Stone & Webster, Inc.; Harry S. New, formerly Postmaster General of the United States; Maurice Newton, Hallgarten & Co.; Edward J. Noble, capitalist, New York; Roland Palmedo, Lehman Brothers; Charles M Packer, executive committee, American Radiator Company; Maj. General Mason T Patrick, retired chief of air service, U S A.; Harry C. Piper, vice president, Lane, Piper & Jaffray, Inc., Minneapolis; Joseph W Powell, engineer and shipbuilder, Boston; Frederick S Pratt, vice president, Stone & Webster, Inc.; Samuel F Pryor, chairman executive committee, Remington Arms Co.; George M Pynchon, Jr., Pynchon & Co.; Edwin E Reeser, president, American Petroleum Institute; James A Richardson, president, Western Canada Airways Limited and director of Canadian Pacific Railway Co.; Alexander B Royce, Chadbourne, Stanchfield & Levy, New York; William E Scarborough, Hitt Farwell & Co.; John D Siddeley, C.B.E., chairman, Armstrong Siddeley Development Company, Limited, Coventry England; Sidney W Souers, executive vice president, Canal Bank and Trust Company, New Orleans, La.; Eugene W Stetson, vice president, Guaranty Trust Co. of New York; G H Walker, president, W A. Harriman & Co., Inc.; Harvey L Williams, president, Air Investors, Inc., and Robert W. Woodruff, president, The Coca-Cola Co.

The Aviation Corporation is at present negotiating for substantial interests in several large established companies in the field representing various phases of the industry. Although the names of these companies have not yet been announced it is expected that several acquisitions will be effected in the near future largely through the issuance of common stock of The Aviation Corporation.

Develop Flying Time Recorder

OAKLAND, CALIF.—According to the claim of its inventors, an accurate record of a plane's flying time may be kept with a new device they have developed here. The "Hourometer," as it is called, is an electrically actuated clock apparatus which when properly attached to the landing gear automatically starts and stops when the wheels leave or touch the ground. Eugene P. Fraser and Malcolm C. Elrick, a former U. of C. student, designed the instrument.

Represents Command-Aire

PITTSBURGH, PA—Aircraft and Airways of America, Inc., eastern distributors for Ryan planes and owner of Bettis Field here, have taken the Western Pennsylvania agency for Command-Aire, according to an announcement by F Le-Moyne Page, president.

Double Pension Granted

WASHINGTON, D C—Double pension for disabilities suffered by Army fliers in line of duty is granted in a measure signed recently by the President. The double amount has previously been allowed to Marine and Navy aviators.

To Hold Model Meet Prior to Detroit Show

DETROIT, MICH.—A nation-wide model airplane exposition will be held in Detroit one week prior to opening of the second annual All-American Aircraft Show under the joint auspices of the Detroit Board of Commerce and the Detroit Board of Education, it was announced recently by Harvey J Campbell, executive vice president and secretary of the Board of Commerce. The exposition, to be known as the Junior All-American Aircraft Show, will be staged in Olympia stadium. It will be in two sections and will be a one-day show.

Through cooperation of the Stout Air Services, Inc. and the Curtiss Flying Service of Michigan the committee in charge of the exposition has arranged to award as prizes in the public school contests 20 aerial tours over the city, two round trip flights to Chicago and Cleveland respectively, $150 in cash prizes, and 17 silver cups. Winners are to be given their prizes on April 9, during the Show.

Last minute assignments of space in the All American Aircraft Show, has increased the number of planes to be shown to 106 craft, Manager Ray Cooper announces. Despite the fact the applications of nearly a dozen manufacturers had to be turned down due to lack of floor space, the show will be the largest indoor aeronautical exposition ever held in this country.

In addition to the 106 planes entered by a total of 62 aircraft manufacturers, there will be exhibits of 107 aircraft accessory makers. Fourteen engine manufacturers have entered their power plants.

Order Placed for 50 Cirrus Power Plants

PATERSON, N. J.—The New Standard Aircraft Corp here has placed an order for 50 American-built Cirrus Mark III engines with American Cirrus Engines, Inc., of Belleville N. J. The first 50 engines turned out at the new Cirrus factory are to be delivered on this order.

New Standard intends to use these engines in its new training plane which is rapidly being completed and will soon be ready for a flight test.

The order, amounting to about $80,000, was signed by Reuben H. Reiffen, treasurer of New Standard, and by Alan C. Hoffman, vice president of American Cirrus Engines Inc.

Schedule Iowa State Meeting

AMES, IA—The Engineering Division of Iowa State College, here will hold a three day conference on aeronautics May 27-29. There will be a program of papers and discussions on aeronautical subjects of interest to engineers pilots, to those connected with air transportation, and to the public in general. An opportunity will also be given to producers to exhibit aeronautical equipment and materials. For further information address Earl B. Smith, Mechanical Engineering Department, Iowa State College Ames Ia.

Congress Passes Air Bills in Last Sessions

WASHINGTON, D C—Four bills affecting aviation became law during the closing sessions of the last Congress. They were Senate Bill 5350, introduced by Senator Bingham, to amend the Air Commerce Act of 1926 with reference to the examination and rating of schools giving instruction in flying; Senate Bill 5544, introduced by Senator Bingham, to increase the membership of the National Advisory Committee for Aeronautics; House Bill 16131 (same as Senate Bill 5443), introduced by Representative Kelly, to enable the Postmaster General to make contracts for the transportation of mail by air from island possessions or territories of the United States to foreign countries and to the United States and between such island possessions or territories, and to authorize him to make contracts with private individuals and corporations for the conveyance of mail by air in foreign countries; House Bill 16839, introduced by Representative Britten, to provide for investigation of sites suitable for establishment of a naval airship base.

Aeronautical Chamber Adds Advisory Group

NEW YORK, N Y—In a recent meeting of Aeronautical Chamber of Commerce members, the following section was added to the by-laws:

"Section 4. Council. To secure the advantages of continuity of service, all ex-presidents past and future shall be members of an advisory group styled 'The Council.' The Council shall cooperate with the Board of Governors and the officers in the direction and control of the affairs of this organization. All members of the Council shall be ex-officio members of the Board of Governors."

There now being three ex-presidents on the Board of Governors, a meeting of the Board will be held in the near future to discuss vacancies to be created by the establishment of The Council.

LeBlond Engines to Kreutzer

CINCINNATI, O—The LeBlond Aircraft Engine Corp of this city has begun delivery on a power plant contract placed by the Joseph Kreutzer Co., Los Angeles. The LeBlond firm, furthermore announces receipt of an order from the Arrow Aircraft & Motor Corp. of Havelock, Neb., for 100 of the "60" type engines to be delivered during March, April and May.

To Begin Thaden Production

PITTSBURGH PA—The manufacture of airplanes will start in Pittsburgh in a few weeks, it was announced here by the Pittsburgh Aviation Industries Corp., a $6,000,000 holding company, with five subsidiary companies engaged in aviation activities. The Thaden plane an all metal monoplane, powered with a Renard engine of 150 hp., will be built.

To Build "Bluebird" Here

NEW YORK N Y—Formation of the Blackburn Corporation of America is announced her by A. R. Martine. The firm, to be capitalized at $7,000,000, will manufacture and sell Blackburn aircraft of the "Bluebird" and other types in this country. The company, Mr Martine states, will be in production this year in a plant whose location has not as yet been announced.

Seaboard Orders 28 Hamilton Metalplanes

MILWAUKEE, WIS.—A contract for 28 planes has been awarded to the Hamilton Metalplane Co by the Seaboard Aircraft Co., according to a recent announcement. The planes will carry seven passengers and a pilot and will be equipped with lavatory, baggage room and other facilities. They will be used between New York, Albany, Boston, Newport and Washington and will make connections at Albany with the Twentieth Century Limited.

Delivery of the planes, to extend over a lengthy period will probably be at the rate of one a month during the remainder of 1929, according to officials of the company. One plane has already been delivered.

It has been announced that Thomas F. Hamilton, founder of the Hamilton Metalplane and Hamilton Aero Manufacturing firms, has moved to Los Angeles, Calif. His duties in the United Aircraft and Transport Co., which recently acquired the Hamilton concerns, have not yet been made known.

Central Americans to Tampa

TAMPA, FLA.—At a recent meeting of the aviation bureau of the chamber of commerce announcement was made that student aviators from Central American countries will arrive in Tampa early next summer to begin training here for commercial licenses. The training courses have been underwritten by various civic organizations and the plan has been approved by the United States Department of State. Official invitations have been sent to the participating nations through the federal department's embassies following the posting of satisfactory bond guaranteeing all costs of the instruction.

Stearmans for Texas Line

FORT WORTH, TEX—Three new Stearman mail planes were delivered here to Texas Air Transport, Inc., during the past week. The planes were flown from the factory at Wichita, Kan., by Texas company pilots. They will be used on the South Texas air mail routes operated by the firm.

Another Fokker for P. A. A.

HASBROUCK HEIGHTS, N J—Delivery of the seventh tri-engined Fokker for Pan American Airways, Inc., is announced at the Fokker plant here. Edward Musick, veteran P A A pilot, came to Hasbrouck Heights to accept the craft.

Sixteen Firms Merge Air Insurance Assets

NEW YORK, N Y—Thirteen long-established fire and marine insurance companies, and three casualty companies, with combined assets for the 16 corporations of more than a third of a billion dollars, have joined their interests to write aviation insurance, according to an announcement made today.

The companies in the new "pool," which is known as the Associated Aviation Underwriters, are "old line" companies represented for many years by Chubb & Son and The Marine Office of America, marine underwriters.

Beginning March 18, these companies will write all classes of airplane risks, including damage by fire, accident, tornado and windstorm, and losses due to theft and pilferage, as well as policies covering property damage, public liability, passenger liability, personal accident, workmen's compensation and loss of use.

The Marine Office companies participating in the undertaking are: the Continental, Fidelity-Phenix, American Eagle, American of Newark, Firemen's, Glens Falls Insurance, the Hanover, and the Glens Falls Indemnity. The Chubb & Son companies are: the Federal, Sea Insurance, Marine Insurance, London Assurance, Alliance Assurance, Merchants Fire of N. Y., the United States Guarantee and the Merchants Indemnity. The three indemnity companies mentioned will assume the liability insurance on the policies written.

The managers of the Associated Aviation Underwriters will be J. Russell Parsons for Chubb & Son, and Owen C. Torrey, for The Marine Office of America, who will decide on risks in collaboration with Alvin W. Smith, formerly with the Aeronautics Division of the U. S. Department of Commerce, where he had charge of establishing air mail routes. Mr Smith is an active pilot of broad experience and also has an interesting war record.

To Start Moreland Plant

LOS ANGELES, CALIF.—An announcement by officials of the Moreland Aircraft Co. states that construction will begin at once on a $500,000 airplane factory to be erected on a site adjoining Mines Field. The first building will measure 80 by 180 ft. in size, will be of hangar type construction and is scheduled to be ready for production before the first of July. Initial production at the rate of one plane daily is scheduled, the first product being a three place high wing open monoplane.

Berliner-Joyce Lets Contract

BALTIMORE, MD—The Berliner-Joyce Aircraft Co. has awarded to the M. A. Long Construction Co. of Baltimore, Md., the contract for the erection of the first unit of the aircraft manufacturing plant at Dundalk Junction, adjacent to the proposed municipal airport. It will be for occupancy in May. The outlay for the first unit and equipment will represent $250,000.

Personnel

George C Westervelt, retired Navy captain associated with aviation for 14 yr, has been appointed manager of Curtiss-Caproni, Inc. During the war, Mr Westervelt was in charge of the construction and inspection of naval aircraft in this country He was identified with the development of the NC flying boats

John L. Hill, formerly of the Carter Oil Co and for a time associated with the Packard Motor Co. has been named vice president in charge of production with the Spartan Aircraft Co., Tulsa, Okla

George Daws, secretary of the New Standard Aircraft Corp., Paterson, N J, has formally been appointed sales manager Edward I Mayer has been designated to assist Mr. Daws with his work, which includes publicity and advertising

William Stout, Seymour Knox, and W W Crocker have been elected to the board of Air Investors, Inc These men are president of the Stout airplane firm, president of the Marine Union Co, and vice president of the Crocker First National Bank of San Francisco, respectively

R S Link is now president of the Aeme Aircraft Corp, Rockford, Ill The firm is in production on its Model 21, a plane suited for training and private use.

Lieut Comdr Paul E Gillespie, for the past three years commanding officer at the Naval Aviation Station, Great Lakes, has joined the Universal Aviation Corp as director of its aero schools Commander Gillespie has a log of more than 2 500 hr in the air

R. P. Rice, Kansas City motor car dealer, will shortly assume the chairmanship of the American Eagle Aircraft Corp board

Frank P Kennedy has been named president of the Rhinelander Airport board of control, Rhinelander, Wis.

J E. Schaefer has been appointed a director of the Stearman firm at Wichita His work combines sales and publicity

Walter H. Beech, Travel Air concern head has been named to the board of Southern Airlines

Harold A Speer, formerly vice president in charge of sales for the International Aircraft Co, Cincinnati, has been appointed sales manager of the Nicholas-Beazley Airplane Co, Marshall, Mo Mr Speer will devote himself to handling the sales of the new NB3 Barling monoplane.

William Winston, for some time connected with the Curtiss company, has now been appointed as director of student aviation in the 25 schools of the Curtiss Flying Service chain rapidly being forged Mr. Winston will first go to Detroit to conduct a class for Curtiss instructors, then he will begin extensive work of organization of the school system.

Donald M Cornell, formerly with the Sierra Aircraft Corp., Chico, Calif, has been engaged as flying instructor by the Aero Corporation of Calif, Los Angeles

Maj C. C Mosely, vice president of the Curtiss Flying Service who will have charge of establishing three Curtiss schools on the West Coast, has been named to the Douglas Aircraft Co. board of directors,

J G Lamb has been employed as general sales manager for the Universal Aviation Schools, with headquarters in St. Louis, Mo

A. E Monteith, instructor on engines; Gerald A. Meritt, assistant ground school instructor, and H B Dewey and C. J. Williams have been added to the personnel of Associated Aircraft, Inc., of Hollywood, Calif

Don L Brown, Andrew V D Wilgoos, and Leonard S. Hobbs, all of Hartford Conn., have been added to the board of directors of the Pratt & Whitney Aircraft Co, engine manufacturer Mr Brown was also made vice president in charge of advertising Mr Brown and Mr Wilgoos have been associated with the firm since its organization in August, 1925, while Mr. Hobbs joined the concern in 1927

Glenn Shomate, field manager of the Southern Air College at Buechel, near Louisville, Ky, is now instructing in parachute work at the school

Bruce Johnson, war flier has been elected president of the Binghamton Aero Club, Binghamton, N Y Other officers are Richard L. Bennett, Richard S. Lusk, and Fred E. Thomas, vice presidents, J Herman Crowley, secretary, and Charles Maricle, treasurer.

New Firms Announced

Aviation Securities Corporation of New England has been chartered under the laws of Delaware for aeronautical financing work The company will begin business with $3,000,000 in cash. It is understood that Hayden, Stone & Co, as well as other banking houses, will participate in financing the corporation

International Aeronautics Investment Corp, newly-formed at Wichita, Kans, will deal in aircraft securities and handle financing projects Incorporators are Karl J Mosbacher T M Thomas, D W Eaton, Frank C. Brosius, and Frank Luther

Hartung Aircraft Corp has been formed at Detroit to deal in Bird planes and Supreme propellers The new firm will operate on Packard Field where a concession for fuel, oil and spare parts is held. Howard C. Hartung, former Packard Flying Service head, is president and general manager, while Ralph W. Snoke is chief pilot

Western Reserve Air-Motors Corp a Cleveland firm with capitalization of $100 000, has been organized to manufacture a new type radial engine Production was scheduled to start yesterday (March 15)

Airways, Inc., has been formed at Akron, O., to deal in and operate airplanes, establish a school of instruction, etc. Albert L Whitney, C. Shirley, Reitzel, and C. J Bolender are incorporators.

The Ranier Aeronautical Corp has been formed in Seattle, Wash, with a capital of $4,500 by Kenneth G Beniferm, Arthur L Lee, and Willard G Von Rumble.

The Briles Flying Service, Inc., has been chartered in Leesburg, Fla, by F E. Briles and others with a capital of $10,000

Aeronautical Calendar

March 23 30	Aviation Show of the Buffalo Chamber of Commerce, Buffalo Armory Buffalo, N Y
April 6-13	Second Annual All-American Aircraft Show of the Detroit Board of Commerce, Convention Hall, Detroit, Mich
May 4	National Elimination Balloon Race for the Litchfield Trophy, Pittsburgh Pa.
May 27-June 2	Indianapolis Aviation Show of the Indianapolis Aircraft Association, State Fair Grounds
May 28 30	Gardner Annual Trophy Race, St Louis, Mo
June 16-27	International Aircraft Exhibition of the Society of British Aircraft Construction, Olympia, London
Aug. 24-Sept 2	National Air Races and Aeronautical Show, Cleveland, O
Sept 6-7	Schneider Cup Race, over the Solent, Cowes, England
Sept. 28	Gordon Bennett Balloon Trophy Race, St Louis, Mo
Oct 12-27	Southwestern Aircraft Exposition, State Fair Grounds, Dallas, Tex

BRIEFLY—

Purchase of Curtiss Field, L. I, by the Seth Low interests which recently acquired Roosevelt Field, L. I, has been reported here Plans to join the two contiguous fields and development of the tract into one large airport were included in the report.

J T Trippe, president and general manager of Pan American Airways, has denied the rumored merger negotiations between his company and the Colonial, Stout and Universal lines.

Maddux Airlines which has extended its operations to link Los Angeles and El Paso by way of Phoenix, Ariz., is to establish headquarters in the latter city. Continental Air Lines is to open an office in Cincinnati in charge of H. E. Barber

The Chance Vought Corp expects to announce details of a new commercial model soon.

Lieut James Doolittle, now conducting experiments in blind flying for the Guggenheim Fund, is expected to make a three hop goodwill flight to Buenos Aires from Mitchel Field, L. I, in the interest of the Curtiss company The first leg will be to the Canal Zone non stop. The second will be to Lima, Peru, and the third will end at Buenos Aires

A. W French & Co, Chicago, manufacturer of Ord concrete, road finishing machines, etc., has merged with the Blaw-Knox Company of Pittsburgh, steel products maker.

In the extensive aircraft operations recently held in the Gulf of Panama in connection with the fleet maneuvers, a total of 237 planes took part, flying 4,399 hr in 1 613 flights Not a single loss of life nor injury was reported

Announcement is made in St Louis of the formation of Allied Aviation Corp, Inc., a $5,000,000 holding company designed to control an airplane, and accessory, and an engine making firm. The subsidiaries, it is said, are Lambert Aircraft Corp, Aviation Accessories Corp, and the Hurricane Aircraft Engines Corp The first is reported to have acquired the assets of Mono-Aircraft while the third has secured control of the Velie Motor Co. engine division.

Lieut. Walter E. Nicol, 107th Observation Squadron, Michigan National Guard, claims a PT-1 endurance record of five hours and one minute. John T Nevill, Detroit representative of Aviation, accompanied Nicol in the flight.

The 23 air mail routes handled 435,531 lb of mail in February, according to the Post Office Department This was a daily average of 15,556 lb as compared with a daily average of 11,353 lb in January The Chicago San Francisco section led in volume with the Chicago-New York section second and the Salt Lake City-Los Angeles section third

Harold H Karr, attache of the Naval Air Station, San Diego, proposes a flight around the world in three hops Karr asserts he has designs for a special plane to be used in the attempt.

Fare for the non stop trip between Chicago and the Twin Cities has been lowered from $40 to $35 by Northwestern Airways, Inc.

Gross Sales of the Aero Corporation of Calif totalled $256 681 for 1928 as compared with $119,944 in 1927 according to a recent announcement of company officials

Plans for an airline between Wichita and Minneapolis with Omaha a stop are being considered

Peter J Brady and John Dwight Sullivan, both of New York City, have been appointed by Governor Roosevelt of New York as members of the temporary commission to study and promote aeronautics in the state.

Increase in capital of the Nicholas-Beazley Airplane Co. from $25,000 to $1 500 000 is announced. The company's fifth supply depot has just been established in Kansas City with the Bredouw-Hilliard Aeronautics Corp., the representative

Capt. Einar Lundborg, Swedish flier who rescued Nobile from the Arctic wastes, will arrive in this country March 20 Captain Lundborg, an instructor at the Malmslaett Military Flying Field, Ostergothland, Sweden, will study aeronautical progress in America.

A Blackburn military flying boat of 160 ft. span is reported to be under construction in England Six engines of a type un named developing a total of more than 4000 hp will power the craft. A similar commercial plane is also to be designed.

General Super-Diesel Motors Corp., Dover, Del, announces that it will shortly produce an eight cylinder air-cooled aircraft engine using oil for fuel

"Captain Carranza," the Stinson mono plane in which Clifford E. McMillan and Joaquin Gonzalez Pacheco were forced down at Birmingham in an attempted Mexico City-Washington non-stop flight has been flown by the pilots to Curtiss Field, L I. A Roosevelt Field-Havana non-stop flight in contemplated.

Contracts for 500 oil temperature gauges and 200 oil pressure gauges have been placed with the Moto-Meter Company for delivery to the Pioneer Instrument Co. of Brooklyn

The 12 persons "who have made outstanding contributions to the advancement of aviation in America since Lindbergh's flight," will be specially honored at the third National Aeronautic Meeting, St. Louis, May 27-30

Capt. W Newton Lancaster, flying alone in a Cirrus powered Avian, has reached Havana on the first lap of a Caribbean Circle tour Captain Lancaster began his flight from the Newark Airport. He is chief test pilot for the American Cirrus Engine Co

Noel Wien, it is reported, has completed a flight from North Cape, on the Siberian Coast of the Arctic Ocean, to Nome, Alaska The 500 mi flight is a dangerous one, for only desolate wastes in which landings are virtually impossible lie between the two points. Wien carried a valuable shipment of furs

Trade Tips

It Has Been Reported That—

—The S A F E firm of which Erle P. Halliburton, Duncan, Okla, is president, will establish terminal buildings and hangars at Tulsa, Oklahoma City, Ft Worth, and Dallas

—W J Patterson, secretary of the board of public works, Superior, Wis, is taking bids on construction of machine shops, offices, and a $25,000 hangar to be 80 by 100 ft

—The City of Duluth, Minn, of which A H Davenport is city clerk, is establishing a 640 acre airport Erection of hangars, beacons, etc., will soon begin.

—In the Middle West, erection of hangars is planned by the Williston Commercial Club, Williston, N D, the American Legion at McCook, Neb, and Pioneer Airlines and Rapid Airlines, recently merged, at Watertown, S D

—Monte E. Owen, secretary of the Board of City Development of Sweetwater, Tex., will erect 80 by 100 ft. and 80 by 50 ft. hangars at the airport three miles west of that city.

—The Eves Construction Co., 1524 La Baig Street, Los Angeles, is preparing plans for a number of steel frame hangars on the site of the new airport in Pasadena, Calif

—The Aeronautical Chamber of Commerce is in receipt of an inquiry from the Woothray Supply Co, 3 Park Place, New York, on behalf of their correspondent in Japan for catalogs and information to enable them to estimate the possibility of following up various lines, as follows "Small articles, materials and instruments required in the manufacture of airplanes, with C. I. F prices if procurable Also materials and jointing appliances for building up airplane bodies, and propeller making machinery" If this is of interest, communication should be made direct with the Woothray concern at the above address

AIRPORTS AND AIRLINES

Huge New York Airport Planned

Leading Aeronautical and Financial Concerns Buy Big Tract

NEW YORK, N Y—Ambitious plans, which if realized would give this city a huge airport on the New Jersey marshes, have been announced here by a group which includes representatives of leading organizations in aviation and strong financial interests More than 600 acres are reported to have been bought and about 165 acres are under contract Title has been passed to New York Air Terminals Inc., a New Jersey corporation.

Back of this project are Hayden, Stone & Co, and representative of Curtiss Aeroplane & Motor Corp, Wright Aeronautical Corp, N A. T, T A T, National Aviation and North American Aviation The board of directors will include Richard F Hoyt, William F. Cary, C. M Keys, Charles L. Lawrance, Robert G Stone, Paul Henderson, Samuel M Greene, "Casey" Jones, John B Hardon, J Cheever Cowdin, James C Willson, George W Pike and Walter J. Bartnett

Adjoins Rail Lines

The property known as Sour Island, is on the east shore of the Hackensack River and extends from the Delaware & Lackawana tracks north along the right of way of the Erie railroad. The larger portion is north of the Erie tracks and the rest is south. It is estimated that the airport will be only about 15 min. from the heart of the city via the Holland tunnel and the express boulevard

On the northwesterly side of the airport will be built a seaplane base about 55 acres in area giving take-offs in any direction of not less than 3,000 ft. The water will be 44 ft. deep Accommodations for dirigibles are said to be included in the plans Complete equipment for housing aircraft and the accommodations of the public, freight and mail will be provided.

Favored in 1927

The site is one of the recommendations of the Hoover Fact-Finding Committee on Airport Facilities for this city in 1927 Although considerable dredging and filling will be required to fully develop the tract it is expected that it will be available for flying operations before the end of the year Railroad facilities are available for manufacturing and assembly parts and the proximity of the tract to New York has suggested the feasibility of a mail tube to the city in case air mail is handled

Airway Mileage Grows

WASHINGTON, D C—On February 15 there were 9,567 mi of airways equipped, under construction or contracted for night flying, with 1 513 electric or acetylene beacons, 269 lighted intermediate fields, 28 radio weather reporting and communication stations and telephone service on the mail routes, and three radio beacons By June 30 2 000 more miles will have been added The Weather Bureau has 22 upper air and 50 meteorological stations over the mail system mostly at airports Eight cities have mooring masts

Conference Arranged Over Airport Quarrel

NEWARK, N J—A conference between Government city and N A T officials was to have been held here Tuesday, March 12 to air the differences between the city and the transport company over use of the new municipal airport as the eastern terminal of the air mail system. N A T. representatives claim the field is not adequate for safe operation. Local officials assert the objections of the N A T have been met but that still the full air mail service is not concentrated there

The specific grievance is in the alleged failure of the N A T to fully use the shuttle service which was instituted as an emergency procedure while improvements to the airport were being affected Only the mail to be transferred to Colonial and Pitcairn planes, now using the port according to Government orders is placed on the shuttle plane, it is declared, while the bulk of the mail is sent directly from Hadley Field to New York City by truck The conference followed an appeal to Senator Edge of New Jersey for assistance in reaching a satisfactory settlement

Begin Use of Section Of Lindbergh Field

SAN DIEGO CALIF—About 35 acres of Lindbergh Field, the new municipal airport here, have been completed and the tract is being used by the San Diego Air Service Corp The outline of the airport has been filled in and, at the present rate of dredging and filling operations it is expected the first complete unit of 142 acres will be ready for use a year from now

Pickwick Airways has a lease at the airport and probably will make it the base for its transportation service between here and Los Angeles and Imperial Valley points. Continental Air Transport Co, formerly the Harry Sperl Aircraft Co, will begin soon a transport service between here and Los Angeles

The first plane of the newly organized Prudden-San Diego Airplane Co, an eight place all metal Wasp engine machine, is expected to be completed about April 1. Three new aircraft factories have been proposed for this city Service on the Maddux lines between here and Los Angeles has increased so that three planes are operated daily each way A site of 400 acres at the south end of the bay has been offered for the Army's proposed depot and 1,000 acres at Camp Kearney have been offered for the Navy airship base.

Mayer to Operate New Line

PITTSBURGH, PA—An air service from this city to Columbus, St Louis and intermediate points, was to have been inaugurated March 15 by the Mayer Aircraft Corp, one of the oldest air companies of this city, it was stated by President C P Mayer The company recently reorganized and recapitalized for $1,000 000 and a tri-engined Ford has been added to the fleet of eight planes It is planned to increase the field to 281 acres.

Location of airport site is shown by white lines Manhattan is in the background

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Pacific Communities Vie for Army Bases

SAN FRANCISCO, CALIF—Decisions of the War Department looking to abandonment of Crissey Field, which has been the Army aviation base in this region since the war, for a new air base and to establish somewhere within the San Francisco Bay area a large quartermaster depot for aviation supplies, have led many communities to offer sites for the two projects.

The latest development is the recommendation made to Washington by Lieut Col Gerald C. Brandt, commandant at Crissey Field that the War Department accept the offer of Alameda of a 311 acre site east of Alameda Airport and the offer of Marin County, on the northern side of San Francisco Bay, of a 500 acre site Colonel Brandt suggested that the depot and either a bombardment or pursuit group base be located on the Alameda site and the other in Marin County

The Alameda site offers the advantages of deep water transportation, rail connection, electric power facilities and an easily developed water supply The Marin County site is northeast of San Rafael Colonel Brandt recently landed a formation of planes on it and made a complete inspection as a result of which he declared the site was unusually favorable Another site offered is on the tidelands owned by the city of Berkeley, on the eastern shore of San Francisco Bay, while a fourth offer involves waterfront property in Richmond, near the straits of Carquinez, at the northeast corner of the bay.

South American Line To Be Opened April 1

WASHINGTON, D C—Operation of the Cristobal-Mollendo, Peru, leg of the new air mail route linking the Canal Zone with Chile will be started April 1, it has been announced by the Pan American Airways The entire route will be operated on and after May 1, it is said, when final arrangements have been concluded with the governments involved

It is reported that Colonel Lindbergh may pilot the inaugural plane over the new route Colonel Lindbergh successfully opened the Mexico City-Brownsville service of the Mexican Aviation Co, a Pan American subsidiary, in spite of some apprehension over a possible interruption of plans on account of the national crisis

Add Lights at New Orleans

NEW ORLEANS LA.—A new rotating airport beacon just installed on the hangar at the New Orleans Municipal Airport is to be supplemented by additional equipment at an early date, according to officials in charge of the field Ceiling lights already have been placed and the installation of other illuminating equipment, including flood and boundary lights is being speeded The airport will be fully equipped for night operations soon.

Turns on Lights For Emergency

SAN JOSE, CALIF.—Vernon Westbrook local air enthusiast, averted what might have been a serious air accident February 26. A northbound Maddux plane, bucking the winds from Los Angeles, was overtaken by darkness short of its northern destination at Alameda Airport. Pilot George Allen, finding his fuel low, determined to land at San Jose, He circled the field several times, blipping his engines as a signal for the floodlights to be turned on but no attendant was on duty and the field remained dark. Westbrook, who lives near the field, heard the engines and guessed the pilot wanted light. He ran to the field, smashed the lock on the switch cabinet, and turned on the floodlights for Allan to make a landing.

Universal Has Dallas Office

DALLAS, TEX—An office has been opened here by the Universal Aviation Corp for sale of tickets and general promotion in the interests of both the air line concern and the cooperating Chicago, Great Western Railroad.

Air Transport Growth Announced in Report

WASHINGTON, D C.—Considerable progress in airways and air transportation development is revealed in recent figures released by the Aeronautics Branch In 1928 the Government paid $7,430,225 for carrying the air mail more than 8,270-000 mi. The income of the mail operators increased from $2,326,400 in the first half of the year prior to the air mail rate change to $5,103 825 in the second half, while the miles operated by the mail planes increased in the same periods from 3,455,-985 to 4,814,096

Fifteen operators are flying about 13,-978 mi daily over 26 lines in non-mail services Altogether there are 35 operators flying over 63 lines carrying either mail or non-mail cargoes, or both On January 31 there were 7,566 mi of lighted airways There are said to be about 2,000 individuals and companies engaged in aeronautics and listed in the Government trade directory. The report states that there are 6,608 pilots licensed or pending, 12,217 students licensed or pending, and 113 models of airplanes and 21 models of aircraft engines approved

Government Bulletins Out

WASHINGTON, D C—Bulletin No 16, "Airport Rating Regulations," a revised edition of Bulletin No 5, "Airports and Landing Fields," and "Airway Marking," the report of the committee on standard marking, are available at the Aeronautics Branch

Operators Want Control of Radio

Committee Representing Air Lines Makes Report at Capital

WASHINGTON, D C.—The air transport companies propose to establish the aviation radio stations throughout the country, according to the recommendations made to the Federal Radio Commission at the conference here March 11 by the subcommittee representing the operators. The channels assigned to aviation would be so allocated, according to Lester D Seymour, chairman of the committee, that they would be available for any and all aircraft passing over the airways

Mr. Seymour requested in his report that the Aeronautics Branch be given charge of passing on application for radio stations and that the subcommittee be allowed to express an opinion on these applications "In turn we promise the closest cooperation and every helpfulness within our power, realizing that the channels for radio use are limited, that the most economic use of each channel must be made and that all who fly and desire such aid to their operations have equal rights, one with the other," said Mr Seymour

The Radio Corporation has no objection to the plan of the operators, if they think they can best be served in that manner, according to Col. Manton Davis. He urged that one agency be created to handle the situation and recommended a general service corporation The Radio Corporation is seeking experimental licenses for aviation radio tests, he said, and is anxious to establish stations at New York, Chicago, Cleveland and Los Angeles.

Nearly 50 experts and leaders in air transportation attended the conference as representatives of the Government, air transportation companies, and various private radio corporations

Gas Company Plans Air Signs

LOS ANGELES, CALIF—Extensive aviation sign posting of southern California cities is being undertaken by the Southern Counties Gas Co All sign painting is being done according to specifications of the Aeronautics Branch About a dozen signs are to be painted on roofs of buildings owned by the Southern Counties Gas Co in Santa Barbara, Ventura, Santa Monica, Monrovia, Pomona, Ontario, Santa Ana, Orange Anaheim, and Newport Beach. The entire project is to be finished within 30 days

Ball Plans New Mail Line

PITTSBURGH, PA—Clifford Ball, operator of the Pittsburgh Cleveland air mail, will open a mail line from here to Washington, he has announced, as soon as the existing line has been lighted for night flying The lighting is expected to be completed by the middle of April Ball has ordered four New Standards, equipped for night flying, one having been delivered.

Alameda, Calif., Opens Airport with Program

ALAMEDA, CALIF—Marking another step in the progress of San Francisco bay district aviation, two day dedication ceremonies were held here recently at Alameda Airport, newest flying field to be officially recognized in this section Ceremonies were featured by the attendance of leading officials associated with the air industry on the Pacific Coast and city officials of the neighboring cities of Alameda and Oakland

Backers of Alameda Airport filed articles of incorporation more than a year ago and the field has been under gradual development since that time but the airport only recently won the distinction of bring one of the most ideal sites for flying purposes in this state With the transfer here of planes and equipment of the Maddux Air Lines, which operates daily service between Alameda and Los Angeles, the airport assumed new importance

Immediately following the conclusion of the ceremonies Captain Thompson announced that work of enlarging the field will be started at once It is planned to make the field one mile square and install landing lights. When completed it will embrace 346 acres, many of which will have been reclaimed from the waters of San Francisco bay The present area of the airport is 75 acres. It is within 15 min of the business district of Oakland and 20 min. from San Francisco.

Norman Goddard, Art Ayers, Franklin Rose, Basil Russell and Capt. William Boyle won in flying contests during the dedication events Miss Joan Edgerton was sponsor for the new field

To Study Capital Airport

WASHINGTON, D C—The Representatives and Senators who are to serve on the joint congressional commission to study the local airport situation include Representative Zihlman, Maryland, Underhill, Massachusetts, Nelson, Maine, Wright, Georgia, Oliver, New York, and Senators Bingham, Connecticut, Vandenberg Michigan Jones Washington Black, Alabama, Tydings, Maryland. The commission was created by the Vandenberg joint resolutions which calls for a thorough study to determine the needs during the next 25 yr, of the Federal and District Governments in connection with a municipal airport Hearings are scheduled to start on the project about April 1, it is reported

Field Dedications Scheduled

MINERAL WELLS TEX—The new 100 acre municipal airport here will be opened formally April 6 and 7, with an air meet which is expected to attract about 40 pilots Amon Arnold has been appointed manager of the field

OTIS, COLO—This town was scheduled to dedicate its new civic airport of 80 acres today, March 16. The tract is located one and a quarter miles north of the town

Holmes Airport Opens

NEW YORK, N Y—About 50 acres of the Holmes Airport, now under development at Jackson Heights, will be available for public use March 16, the promotors have announced The entire tract includes about 220 acres A dedication program of flying was arranged by the Gates Flying Service which will operate at the field

Curtiss Plans Denver And Kansas City Units

KANSAS CITY, MO—Announcement has been made here by officials of the Fairfax Airport Co., operators of Fairfax Field, that the Curtiss Flying Service has selected that field as the base of operations for a unit of its organization

Ray G Sparks of this city has been appointed manager and will head all the Curtiss operations, including a flying school, aerial taxi service, aerial photography and mapping service, sales service of airplanes and parts and a department for the overhauling of planes and engines

About $225,000 will be spent by the Curtiss group in developing the base, according to R. F Craig, manager of the Fairfax Airport Co

Reported plans call for the immediate erection of two steel and brick hangars each 100 by 100 ft and a two story annex, 22 ft wide, running the entire length of the hangars for offices and class rooms, A dormitory is proposed, also

A $40,000 airport, flying school and air taxi line will be built in Denver by the Curtiss Flying Service, Inc, in June, according to an announcement by Maj Bruce Kistler, commanding officer of the Colorado National Guard flying squadron The Denver branch of the company will cover territory between El Paso, Tex., and Montana The airport site has not been selected.

Airports Proposed

WASHINGTON, D C—The following 32 communities have announced plans to establish airports Huntsville, Ala; Azusa, Cal, Point Washington, Fla, Atlanta, Ga., Jacksonville and Chicago, Ill, Culver, Ind, Hiawatha Kan., Wiscasset, Me, Cambridge Md, Berkeley, Birmingham Clawson and Royal Oak, Mich.; Natchez, Miss, Brooklyn, Chatham, Hicksville and Liberty, N Y, Rich Square, N C., Sterling, O, Louisiana, Mo, Harrisburg, Lancaster and Philadelphia, Pa; Eagle Pass and Edinburgh, Tex, Grottoes and Wing, Va; Cleelum and Kennewick, Wash and Milwaukee, Wis

To Add to Texas Service

FORT WORTH, TEX—Two more air passenger routes will be inaugurated within a month by Texas Air Transport, Inc., according to an announcement by A. P Barrett president The lines will operate between Fort Worth, Dallas and Houston and between Fort Worth, Dallas and El Paso When inaugurated the lines will make a total of three passenger routes operated by the firm. The initial line went into operation between San Antonio Corpus Christi and Brownsville March 9

New Orleans to Ask Bids on New Airport

NEW ORLEANS, LA—Immediate advising for bids for the construction of an A-1-A airport on the shores of Lake Pontchartrain, on the outskirts of the city, were authorized at a special meeting of the Orleans Parish Levee Board recently held in the civil courts building The work will include building of a concrete sheet-piling bulkhead and filling a site 3 000 by 2,800 ft approximately 1 000 ft from the center of the Industrial Canal at its entrance into Lake Pontchartrain, eastward. Bids will be received up to 3 P M, April 8.

According to A L. Shushan chairman of the levee board's airport committee, the fill should be completed within five months after the letting of a contract. Several additional months will be required to permit the fill to settle and to construct hangars and other appurtenances Owners of summer camps along the lake 3,000 ft. east of the canal will vacate by May 1

J A Thomas and H W Waguespack, recently appointed to fill vacancies on the board caused by the resignation of Waldo M Pitkin, and W D Gardiner were inducted into office at this meeting Construction of the airport is being taken up by the levee board as a part of plans for the general development of a large tract of land along Lake Pontchartrain and the Industrial Canal which joins the lake with the Mississippi River

Would Place Landing Facilities 10 Mi. Apart

WASHINGTON, D C—A suggestion for placing landing fields all over the country at intervals of 10 mi in the form of a gigantic checkerboard has been made here by the Guggenheim Fund The scheme is advanced as a remedy for the lack of sufficient landing area, which is called one of the two main problems of aviation the other being airplane engineering perfection which is regarded as practically achieved

By this checkerboard system, it is declared, no pilot under conservative circumstances would have to be out of gliding distance of landing facilities in case of trouble The land devoted to this project, the backers say, would be 1 544 sq mi, or only 3 per cent of that allotted railroads and highways.

Small Airport Train Suggested

OAKLAND, CALIF—Construction of a miniature railroad for passenger and express transportation has been proposed for the local airport, and the purchase of a miniature railway used to carry passengers at the Panama-Pacific International Exposition in San Francisco in 1915 has been suggested to airport officials.

Florida Mail Increases

PHILADELPHIA, PA—About 60 per cent more air mail was carried over the Atlanta-Miami line in February than in January according to reports

FOREIGN ACTIVITIES

France Reorganizes Civil Aviation System

PARIS, FRANCE — French civil aeronautics have been reorganized into three systems or departments—continental Europe, the Orient and the Occident. Existing companies will cooperate in the operation of the department to which they are assigned. The International Air Navigation Co, and the Farman lines will combine for the operation of the continental Europe department The Air Union and Air Union-Orient lines will operate the London-Paris-Marseille and France-French Indo-China services The General Air Postal company will operate to South America

Changes in the contracts with the government and in the subsidies were announced at the same time. The 10 yr contracts have been extended to 30 yr with the reservation by the government that it has the right to buy back the air lines at the end of 10 yr. without having to pay an indemnity This reservation is said to pave the way for an international operating company in the future

A flexible subsidy system has been substituted The allowance henceforth, instead of being at a fixed rate as at present, will be decreased as the companies show credit balances for one or two fiscal periods The government will subscribe 25 per cent of the capital stock of the companies and to aid them in establishing credit will guarantee interest on authorized loans Temporary cash advances will be made, also Railway and steamship companies cooperate by taking stock in the air concerns.

Foreign News Briefs

The Canadian Department of National Defense has agreed to supply and maintain airway beacons between the principal Canadian aerodromes to aid night flying in the Dominion Assistance will be given in the equipment of the aerodromes for night flying, also

It has been suggested that this year s King's Cup race an annual event of considerable prestige in English flying circles, be made a race between Croydon and Karachi, India, rather than around a course restricted to the United Kingdom

The Western Australia Centenary East-West Race of 2 400 mi is to be staged in the Fall with $5 000 as the first prize The race will be flown in six stages and is open to any pilot in the world

Sioux Lookout Ontario, Canada, claims to be the second largest operating base for commercial aircraft in North America, Chicago rating first Western Canada Airways, Northern Aerial Explorations, Ltd, and Provincial Air Service each operate four planes a day from this port.

The International Exposition at Seville, Spain which was to have opened March 15 with an elaborate aeronautical department, has been postponed to May 7 on account of the strict mourning period for the late Queen Maria Cristina.

Tests are expected soon in England on what is called the "helicogyre," a machine designed by Vittoro Isacco to rise and descend almost vertically. It employs huge horizontal vanes similar to the Cierva autogyro, two of the blades having small engines and propellers mounted on them to increase the revolutions and lift. The device is financed by the government

Commercial air service between Edmonton, Canada, and Fort Vermillion, 700 mi away in the Peace River country, was started recently

Air lines entering Basel, Switzerland, handled more than 6,000 passengers last year There was an increase over 1927 of 33 per cent in passengers, 61 per cent in mail and 127 per cent in freight

U. S. Leads in Plane Types

LONDON, ENGLAND—According to "Jane's" 1928 edition of *All The World's Aircraft*, the number of types in leading producing countries are as follows

Great Britain, 96, Czechoslovakia 12 France, 109, Germany, 54 Holland 11; Italy 44 United States, 148. The number of engine types given are Great Britain, 25, France, 40, Germany, 12, United States, 28. The division between military and civil types is as follows Great Britain, 60 and 36, France, 74 and 35 Italy, 31 and 13, United States, 54 and 96 and Germany, 54, all of civilian type only United States manufacturers are unique in specializing on either military or civilian craft, for the most part, while in Europe manufacturers usually build both types

Children Carried Free

MELBOURNE, AUSTRALIA — All children three years of age and under now may travel free of charge on planes of the Australian Aerial Service, if accompanied by an adult. Children up to seven years of age may travel alone on the planes but must pay the regular fare. These arrangements were made necessary by the increase in number of juvenile air travellers This company has completed 100 per cent of its scheduled trips since its organizations in November, 1924, and has had no fatal accident

Canadian Insurance Rates Recommended

OTTAWA, CANADA — Insurance companies in the Dominion have received recommendations covering the problem of insurance to those engaged in aviation The recommendations are the result of considerable study of the situation by an Aviation Rating Commission of the Actuaries Club The rates suggested are considered only temporary while the study is being considered further on the basis of current experience.

Among the recommendations is the provision that the extra premium per $1,000 for a licensed pilot flying a licensed passenger plane between well equipped airports and over established routes shall be from $15 to $25 The same pilot flying only mail would have to pay $25 extra Mapping and forest patrol flying for the government involves only $15 but the same work for a private concern involves $25. A stunt pilot or private owner-pilot would not be accepted

R C A F regulars and reserves must pay $20 and $10, respectively while members of the U S Air Corps regular or reserve would have to pay $30 and $15 respectively, if desiring to be insured under the Canadian system Fare paying passengers flying over regular airways between well equipped airports pay according to the number of flights contemplated For between 11 and 20 flights a year, the extra premium would be at the rate of $5 per $1,000, 11 to 20 flights a year, $10, 21 to 40 flights, $15 Private owners employing licensed pilots must pay $15 to $50

Westland Limousine Tested

YEOVIL, ENGLAND—Pilots of Westland Aircraft works, makers of military types and the Widgeon light plane, recently flight tested the concern's latest product, a tri-engine commercial cabin monoplane accommodating four passengers, and designed as the Westland Limousine It flies and climbs with any one engine out of commission and was built to provide an all-weather machine suitable for feeder line service The first of 28 Wapiti general purpose military machines for Australia was christened recently

Canadian Imports Jump

OTTAWA, CANADA—Airplanes imported into this country from the United States during the first nine months of 1928 totaled 89 as compared with 25 in 1927. Imports from England totaled 90 for the same period as compared with 6 in 1927. The aircraft imports represented an increase of 390 per cent over 1927

BUYER'S LOG BOOK

Electric Furnace

ELECTRIC FURNACES of the 60 K W circular pit type for heat treating airplane engine crank cases, cylinder heads, pistons, and other parts, are now being manufactured by The Electric Furnace Co of Salem, O These furnaces accommodate circular steel baskets 55 in in diameter and 60 in deep and have electrical capacity for heating to a temperature of 1,000 deg F, 300 lb of steel and 650 lb of aluminum in 1¼ hr The actual production and time cycle depends on the analysis of the metal being treated

An electric furnace used for cylinder heads

These furnaces are equipped with two point recording temperature controllers for automatically controlling the temperature of the equipment within a range of plus or minus 5 deg C

Power "Dolly"

PROBABLY THE hardest work in airport operation is the handling of planes between hangar and field, and usually several attendants are required for this purpose. To reduce this operation to a one-man task, the American Eagle Aircraft Distributors Inc, 83 Huguenot St, New Rochelle, N Y, has developed a power "dolly"

The power dolly consists mainly of an automobile chassis and driver's seat with a crane attached at the rear to pick up the tail skid of the plane to be moved The crane is operated by hydraulic pressure from the engine of the automobile It can be raised and lowered without the operator leaving the seat and it is designed to accommodate any size plane

A photograph showing the use of the power "Dolly"

This machine was built by C Robinson, vice president and general manager of the company and production is planned if warranted by the demand

SIDE SLIPS

By Robert R Osborn

Mr. L C M, of Highlandtown, Baltimore, Md, sends in a note—"Enclosed please find an extract from the Baltimore *Sun* of January 24 describing a rather unusual method of landing:

THE LEAP

From the top of the summit—fly
Look not down, look on high
Thus without hurt you shall land,
While faith holds his hand

* * * * *

The Intrepid Aviator stopped in the other day to show us a news item about a wealthy young chap who is planning to make an extended big game hunting trip in an airplane. In describing the equipment he proposes to use the article said, "A special vaporizer to convert sea water into a drinkable liquid is another feature to guard against potential disaster" The Intrepid Aviator said that this was the first inkling he had of the apparatus his bootlegger had been using lately, and he was on his way around to warn him that it wasn't drinkable liquid and if he delivered any more stuff like that, the potential disaster would become a reality

* * * * *

The news item about the pilot—big game hunter also stated—"To prepare himself as a first-class pilot he flew last year on the European K. L. M Air Line" We suppose he flew the mail a while to get the second class rating after soloing in the First Pursuit Group

* * * * *

Mr J E M of Chicago sends in a clipping and a comment thereon—"Here's a note on Mr Slate's new airship, as described in the rotogravure section of the esteemed Chicago Daily News I suppose Slate has it covered in the patents" The clipping shows a picture of the new all-metal dirigible with the caption, "A fireproof dirigible The airship's framework is of metal and it is covered with slate The picture was taken from the roof of the hangar at Glendale, Cal'

* * * * *

Aside to W C N of San Francisco You'll have to blame that slip on the proof room We've been pointing out so many newspaper mistakes lately in this space they probably can't tell our mistakes from the others

* * * * *

An interesting news item is called to our attention by W C of Sacramento Calif—"Los Angeles, Dec 17—An airplane pilot has qualified as a matador without going near a bull ring Engine trouble force Albert Fisher to land hastily and he landed on a bull The bull was killed and the plane damaged, but Fisher escaped serious injury" Having seen the wreck a bull made of a friend's plane after he had negotiated a forced landing in the field one day we'd say that Mr. Fisher knew what he was doing in landing on the bull and settling the matter at the outset

* * * * *

The latest report by the Aeronautical Chamber of Commerce stating that commercial aircraft production in 1928 had increased 140 per cent appeared at nearly the same time as the report from Curtiss Field that a student there had washed out three ships in one bad landing, indicating that the crash rate has increased 200 per cent

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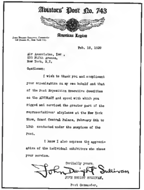
ACCURACY



Aviators' Post No. 743

American Legion

John Dwight Sullivan, Commander
[illegible] Nassau St., New York City.

Feb. 19, 1929

Air Associates, Inc.,
535 Fifth Avenue,
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Gentlemen:

I wish to thank you and compliment your organization on my own behalf and that of the Post Exposition Executive Committee on the ACCURACY and speed with which you rigged and serviced the greater part of the representatives' airplanes at the New York Show, Grand Central Palace, February 8th to 13th conducted under the auspices of the Post.

I know I also express the appreciation of the individual exhibitors who chose your service.

Cordially yours,

John Dwight Sullivan

JOHN DWIGHT SULLIVAN,

Post Commander,

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Kitty Hawk
Bellanca CH
Lockheed "Vega"
Lockheed "Air Express"
Avro Avian
Eaglerock Biplane
Whittlesey Avian
Spartan
Buhl Senior Airsedan
Travel Air Monoplane
Travel Air Biplane
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(In April: Chicago Municipal Airport)

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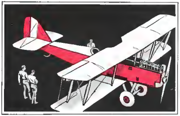

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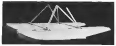

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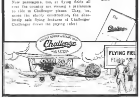

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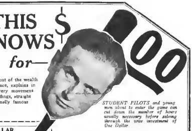

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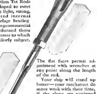

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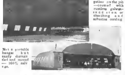

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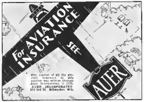

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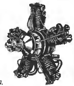

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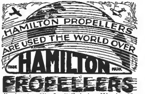

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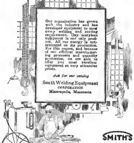

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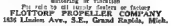

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(Continued)

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AVIATION

AERONAUTICAL ENGINEERING SECTION

CONTENTS

March 16, 1929

Fundamentals *of* Airplane Fitting Design

By Richard C. Gazley

Aeronautical Engineer, Department of Commerce

FITTINGS form a much more important part of airplane design than a casual consideration would tend to reveal and deserve more attention than is usually accorded them They are nearly always in such positions that failure of one would wreck the airplane They are necessarily points of concentrated stress and must distribute heavy local loads properly into adjacent structural members

In addition a fitting is usually of such a complex shape as to be the most difficult part of the airplane to analyze. It almost never fails in the obvious or expected manner but twists and distorts with consequent shifting of the applied loads Because of these facts fitting design has a tendency toward the arbitrary. Empirical methods and formulae are the most satisfactory means of analysis and design but their application must be tempered with judgment and a diversified knowledge of the subject

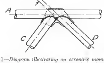

Fig 1—Diagram illustrating an eccentric moment in fitting attachment Member D is eccentric by the distance X in the drawing

A complicated fitting can present so many problems simultaneously that its design takes on all the aspects of attempting to witness a three-ring circus There are, however, a number of fundamental principals which always apply, and a thorough appreciation of these fundamentals is essential to the design of safe and satisfactory airplanes

Perhaps the most axiomatic of these fundamentals is the principal of concentricity It is important that a fitting be so designed as to join the neutral axes of its structural members at a common point This is not always possible, of course, and in such cases due allowance must be made for the moment which results from the necessary eccentricity An eccentric moment tends to rotate the fitting This tendency must be restrained by the structural members to which the fitting is attached Nearly always the members in question have been designed with only sufficient strength to withstand the maximum axial loads which may be imposed upon them If the eccentric moment and this maximum axial load occur simultaneously the member will be overloaded and may fail It sometimes happens that the eccentric moment alone is large enough to cause failure

This point which appears to be so simple as to be obvious is entirely overlooked in a surprisingly large number of instances Fig 1 will present the idea more clearly.

Members *A* and *B* are longerons *C* and *D* are members of the fuselage side truss Member *D* is eccentric by the distance *X*

The load in member *D* is P_d

The eccentric moment is the P_dX

This moment will be divided between members *A*, *B*, *C* and *D* in proportion to their respective moments of inertia, provided they are all of the same material Each of these members should therefore be investigated for the effect of its share of the eccentric moment plus the simultaneous axial load acting upon it.

There is a proviso to the above example which introduces another principle of fitting design That principle is the fact that no fitting is of any value unless properly attached to the structural members which it is intended to hold together If the joint in Fig 1 were riveted, the rivets holding member *C* might be so spaced or so few as to be incapable of carrying any appreciable rotating moment In that case almost the entire moment would be borne by the remaining three members which are more rigidly attached

It occasionally happens that the method of attaching a fitting weakens the member to a figure below its design strength This could be caused by drilling too many holes, by burning or annealing during the process of welding, or by placing the centroid of the attachment eccentric with the neutral axis of the members Of these three the last mentioned is the most common and sometimes bring about a dangerous situation

Fig 2—Illustrating an improper attachment between a wing spar and a lift strut

Fig 2 illustrates an improper attachment between a wing spar and a lift strut It will be seen that bolts 1 and 2 carry most of the imposed load and that bolt 4 is practically useless Unless bolts 1 and 2 are strong enough to carry the entire load, without causing undue elongation of the holes, the joint will fail

A prevalent example of inefficient fitting attachment occurs in cases where spar fittings are attached by means of vertical bolts through the spars This method removes material from the spars in such a manner as to effect appreciably their moment of inertia In wood spars it has been found necessary to make the fitting wrap around the spar to prevent splitting when vertical bolts are used When the extra weight of the box is considered, and the difficulty of fitting it, one believes that a different type of design could be used to better advantage

These points may, of course, be foreseen by any designer who remembers his theories of mechanics and they usually are. One factor, however, which is not universally known and has been disclosed by service operations, is the effect of vibrating or reversing loads upon joints

It has been found that bolted joints, unless reamed to a perfect fit and provided with ample bearing area, will inevitably pound out in a surprisingly short time under reversing or repeated loads Once the holes begin to enlarge, of course, the process accelerates and frequently the fitting either breaks out or becomes dangerously weak before it is noticed This is so invariably true that no pains should be spared in the design and assembly of such joints in order to prevent an occurrence of this nature

The writer believes that this point cannot be overstressed and that its importance is not fully realized because a number of cases of sloppy initial fits and insufficient bearing area in bolt holes have come to light In one case the owner of a plane which had only been in service a few hours complained that he could not keep the wings in proper alignment, even though he was constantly adjusting the wires Upon investigation it was discovered that he was rapidly pulling the bolt out of one of his wing fittings. The bolt hole had been drilled carelessly in the first place and its original oval shape had allowed the bolt sufficient space in which to pound it to larger proportions There was enough bearing area under the bolt in this instance to withstand the design load in a static pull but not enough to guard against repeated stresses Lieutenant-Commander Richardson, who is in charge of the U S Naval Base at San Diego, said, in a recently published article, "Designers are invariably optimistic regarding the bearing strength of their fittings —the repair of fittings, in which holes have become elongated, is a major item in maintenance "

Require 20 Per Cent Margin of Safety

In all cases except such extremes as float attachment fittings a satisfactory situation will result if a calculated margin of safety of 20 per cent is incorporated in the fitting and the bolt holes are carefully reamed to size Float attachment fittings unfortunately fall into the class for which design loads are impossible to calculate with any reasonable degree of accuracy The indeterminate nature of the load imposed upon floats and float gear, and the severity of the application of these loads, combine to render the design of this unit highly arbitrary and subject to revision if actual operation in a particular case is unsatisfactory The fittings in float gear have been the worst offenders in the matter of elongated holes and it has been found here that very carefully reamed bolt holes are the only alternative to excess fitting weight Although this offers a good example of the effect of repeated or reversing loads the magnitude of the imposed loads is not calculable so that we can obtain no quantitative data from this source A series of laboratory experiments along this line would be comparatively easy to perform and would be of considerable benefit

An absolute knowledge of the physical properties of the materials actually incorporated in an airplane is another essential which would appear to be obvious but which has been frequently neglected in commercial aircraft, with consequent trouble

In the case of steel it so happens that the market is flooded with so-called "commercial" steel, which is being purchased for use in aircraft This grade of steel may possess any physical properties which are inferior to those of S A E specification 1020. Its physical properties and chemical composition are not guaranteed to the purchaser. It is, consequently, cheap and popular Airplane designers working with steel plate fittings almost invariably assume that 1020 steel, or better, will be used and they design accordingly If the manufacturer purchases a cheap grade of commercial steel without specifications and check static tests he not only lowers the strength of his airplane but may actually make the machine a distinct menace by unwittingly including materials which are brittle or soft or which contain segregated grain structures and weakening impurities Unless the engineer bases his strength calculations upon specifications which the material manufacturer guarantees to and does furnish, he is wasting his time.

Selection of Material is Important

All of which brings up the point of the selection of the most efficient material for a given case. Availability narrows the range of choice to a comparatively few materials At the present stage of the industry an airplane manufacturer must order his materials in comparatively small lots and must demand prompt delivery A material which is not in sufficiently common use to be in the regular stock of a supply house or mill is prohibitive in cost and takes too long to obtain

The fitting materials which are in most common use and are consequently easily available are aluminum alloy, various grades of carbon steel, and some steel alloys such as chrome molybdenum and nickel

A discussion of the choice of materials is of course inseparable from a consideration of the type of construction to be employed Although welded steel plate fittings are most widely used there is much to be said in favor of forged and cast material Similarly, the fact that welded joints are generally employed does not mean that such joints are necessarily superior to riveted or bolted construction The following is therefore a rather brief outline of the situation both as to material and type of construction

Carbon steels which conform to S A E specifications 1015 to 1030 and chrome molybdenum steels of S A E specification 4130 are in general use because they lend themselves readily to welding

All steels are somewhat annealed during a welding process and are chemically injured but some are effected less than others Chrome molybdenum steel is probably injured less than any other high strength alloy and is consequently very desirable for parts to be welded, provided that little or no machining is required Machining and forming heat treated chrome molybdenum steel is so difficult as to be usually impractical The constant replacement or sharpening of dies and cutting tools is an appreciable expense It is, of course, possible to buy annealed sheets of this material which will adapt itself very nicely both to machining and welding This would be reliable and tough but would possess tensile properties so little in excess of those given by 1025 steel that the added cost of raw material would not be justified

One method which is occasionally adopted is that of forming and welding the fitting from annealed alloy steel and heat treating the finished product to the desired physical properties This method appears on its face to be

logical and good, but actually possesses a number of faults.

In the first place it is expensive. The heat treatment of steel necessitates proper equipment and skilled workmen, if performed by the airplane manufacturer, and extra cost if done outside the factory.

The most serious objection, however, arises from the fact that heat treatment, particularly of complex shapes, causes internal stresses in the fitting which are not wholly relieved by normalizing. The external evidence of these internal forces is the distortion which frequently accompanies heat treatment.

Such distortion is also an evil because it involves the necessity for straightening the fitting by some means or other. If this straightening is accomplished on the cold fitting we have the incalculable effect of cold working added to the equally incalculable effect of heat treatment stresses and the result is a fitting which is designed to carry exactly a certain load but which may be actually working almost to capacity before any load is placed upon it.

The above facts apply particularly to alloy steel fittings but the effects of torch welding, which is, of course, a form of heat treatment, are such as to extend the same line of reasoning to all welded steel plate fittings.

The effect of the unequal distribution of heat coincident with welding is to produce internal stress and external distortion. These distorting stresses are frequently of sufficient magnitude to crack the fitting. The writer has seen ¼ in. chrome molybdenum steel plate split open while cooling after being welded into a fitting. In this particular case the fitting was scrapped and no harm resulted except the not inconsiderable cost of the fitting itself. If the distortional stresses are not quite sufficient to rupture the part, the cracks will not develop until after the fitting has been placed in service and might escape detection until they cause an accident.

These things occur even in cases where the welding is carefully and skilfully done. If the welders are not skilled or make an occasional error anything might result. The material around the weld may be burned so that it is seriously weakened or may not be heated sufficiently to obtain proper fusion between parts. Poor welds may usually be detected by very careful scrutiny but there is a considerable element of doubt even in the minds of specialists in many cases.

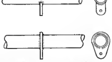

Fig. 3—A typical example of faulty design found by Department of Commerce engineers in the attachment of adjusting parts to the front spars of stabilizers

This uncertainty is the principal reason for avoiding the use of welds in pure tension. A tension weld may be proved amply strong by static test of a good specimen but its tenacity depends entirely too much on the individual skill of a welder to make it a safe proposition. As a matter of fact several tension welds have recently broken loose in commercial aircraft. They were approved by the Department of Commerce because their failures would not seriously cripple the airplanes but they served as good examples of bad practice.

One of the most recurrent examples of this sort of fitting has been observed and corrected on approximately 25 per cent. of the airplane designs submitted to the Department for approval. On these airplanes the designers had attached the stabilizer adjusting post to the stabilizer front spar by means of a lug which was butt welded to the spar. Fig. 3 shows this dangerous type of fitting and a possible remedy. A sleeve should also be placed around the spar at this point if it is a thin wall tube in order to prevent undue concentration of stress. Two of the earlier types of airplanes crashed and several fatalities are recorded as a result of the breaking of one of these butt welded lugs.

Effect of Repeated Bending Loads

Repeated bending loads, particularly when rapidly applied, have a bad effect on welded joints. They appear to cause cracks in the material just at the edge of the weld. This trouble has been most noticeable in engine mount structures and has been avoided by placing gussets at the joints.

It is well to mention one other peculiarity of this type of joint. Two plates of widely different thicknesses are difficult to join satisfactorily. When the thickness of one piece is more than three times the thickness of the other the joint is almost certain to be unsatisfactory even if the heavier piece is pre-heated. The difference in time necessary to thoroughly heat the two parts usually results either in burning of the thin piece or insufficient fusion to the thick one.

In addition to these faults torch welding has the disadvantage of not being adaptable to quantity production. Of course large quantity production is not in existence as yet but it seems to be imminent and an important factor in projected designs.

All of the above statements apply to hand torch welding on carbon steel or chrome molybdenum steel plates. Other methods of welding are being experimented with. Electric welding appears to have some points in its favor. Insufficient data exist to form a proper basis for comment however because torch welding is almost the universal practice.

Other materials might conceivably produce better results but here again there is very little available information.

Of the alloy steels, nickel (S.A.E. 2330) does not weld satisfactorily and chrome vanadium (S.A.E. 6120) does. A few aircraft manufacturers have attempted to carry loads by welding nickel steel bolt heads to structural members. This is a very unsatisfactory proposition and cannot be counted upon to produce reliable results.

Aluminum alloy sheet and tubing welds beautifully but retains only the strength of soft aluminum after welding and cannot then be heat treated satisfactorily. It can be used in this way only in places where strength is a minor consideration. Fuel tanks and such things are sometimes made of aluminum alloy and welded at the seams.

Fittings of aluminum alloy need to be riveted or bolted. Riveted construction introduces a number of problems, which, if not properly understood, occasionally lead one to the belief that this type of construction is impractical and unsafe. It is, as a matter of fact, a reliable means of fabrication and a number of tools now on the market help to make it easily adaptable to quantity production.

There are several features about riveted joints which make the exact calculation of their strength impossible. Rivets are occasionally imperfect in spite of careful heat treatment, skilled heading, and painstaking inspection.

Rivets with cracked heads, when discovered, should of course, always be removed and replaced with fresh ones. Internal imperfections cannot be seen, however, and the possibility of their presence introduces a certain element of doubt concerning the absolute integrity of the structure.

Another manufacturing imperfection is introduced by the fact that holes in the parts to be joined do not always match perfectly. The rivet inserted in the imperfectly matched holes will usually not fill the entire space and consequently will bear only on one side in one of the members. This means that the rivet can carry loads in one direction only unless the rest of the group deforms sufficiently to allow bearing upon the imperfect one. If such deformation takes place it will loosen the rivets and hasten the breaking down of the joint under repeated or reversing loads.

This same situation occurs if one of the rivet holes is drilled so as to be out of round, or oval in shape, or if the drill is not centered accurately and thus makes an enlarged hole.

These things, together with the fact that the imposed loads from the attached members are nearly always unavoidably eccentric with respect to the rivet group, introduce local eccentricities and consequent unlooked-for stresses in the fitting. The magnitude of such stresses will vary, of course, with the variation of conditions. If, however, calculable eccentricities are reduced to a minimum, the rivets are properly heat-treated and carefully headed, and careful inspection of the finished job is conducted, it is safe to say that a calculated strength 30 per cent. in excess of the design load will insure a reliable and entirely satisfactory fitting. This figure is based upon experience gained from reports of a number of airplanes which have incorporated this type of construction and is therefore purely empirical. About four years ago a well-known aircraft factory, in which all details of design and construction are of the best, discovered that riveted fittings which were designed to incorporate only a strength equal to the design load were highly unsatisfactory. They did not stand up in service. This company then swung to the conservative side and strictly observed a rule which required all riveted fittings to be designed for 150 per cent. of the calculated design load. Profiting by this experience, another equally commendable factory has built more than one hundred airplanes, with riveted construction, upon the basis of 30 per cent. excess and the results have been entirely satisfactory.

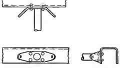

Fig. 4—Diagram showing a drag wire lug in which rivets are made to work in tension. This is another example of bad practice.

Another fundamental rule is that rivets cannot be made to work in tension. Fig. 4 illustrates a drag wire lug in which this principal is used. One is frequently tempted to incorporate such a feature in a fitting but it absolutely will not work. The cold working which has been performed on the rivet makes it very weak at the base of the head sothat the head will pull off upon the application of only a small load.

In order to save as much weight as possible it is necessary to group the rivets as close together as they can be efficiently. When rivets are in line with the direction of the force the minimum spacing can be easily calculated. It should be such as to provide a shearing strength between holes which is equal to the bearing strength of the hole or to the shearing strength of the rivet; whichever is the least. An example follows:

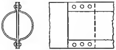

Fig. 5—A drawing illustrating the problem of finding the minimum permissible spacing between rivets

Given the joint in Fig. 5 with ⅛ in. aluminum alloy rivets. The plate is .095 in. aluminum alloy, heat-treated to a minimum tensile strength of 55,000 lb. per sq. in. The semicircular member is of the same material, .051 in. thick. To find the minimum permissible spacing between rivets.

The cross-sectional area of each rivet is .0123 sq. in. Each one is working in double shear so that its shearing strength is equal to .0246 x 30,000 = 740 lb.

The thickness of both semicircular members is more than the thickness of the center plate so that the bearing strength of the plate will be critical. The bearing strength of each hole in the plate equals .125 x .095 x 75,000 = 890 lb.

The shearing strength of the rivet is the lesser value and will determine the distance between holes. The shearing strength of aluminum alloy sheet is 27,000 lb. per sq. in. where the sheet is thicker than .0625 in.

The required shear area between holes in the plate

$$= \frac{740}{27000} = .0274 \text{ sq. in.}$$

The usual method of calculation is to assume that the cross-sectional area between the nearest edges of the holes works in double shear. The required distance between the edges of the holes in the plate is then equal to $\frac{.0274}{2 \times .095} =$ .144 in. and the distance between centers is .144 + .125 = .269 in.

When aluminum alloy sheet is less than .0625 in. thick it is advisable to design for a shear strength of not more than 20,000 lb. per sq. in. It is therefore necessary to check the spacing in the semicircular members.

Each side will carry half the load. The required shear area on each side equals $\frac{370}{20000} = .0185$ sq. in.

The required spacing equals $\frac{.0185}{2 \times .051} = .182$ in.

The distance between centers of the rivets in Fig. 5 then must be at least .182 + .125 = .307 = approximately 5/16 in.

The spacing at right angles to the line of action of the load may be calculated on a somewhat similar basis using

not very greatly below the melting-point, then, when the torch is applied to any one point, the additional expansion of this will be small and is unlikely to cause distortion. However, local preheating must be applied with care, especially in castings, for the presence of strengthening ribs, or other devices which tend to prevent the free expansion of the parts, can possibly lead to fractures during the preheating itself

The preheating of the whole object is not always possible, and in such cases local preheating must be resorted to When total preheating is adopted there is little danger of expansion cracks, provided the heating is done slowly and uniformly, and that the object is well protected from drafts during welding

A broken aluminum crank case may be taken as a typical example of a cast aluminum job requiring preheating A crank case and broken piece are shown in Fig 7 The crank case is thoroughly cleaned and the broken pieces clamped in place The crank case is placed in such a position that the crack to be welded is in a horizontal plane A furnace is built about the casting, using fire brick laid snugly without mortar A moderate amount of charcoal is placed in the furnace, banking it against the walls The exact amount of charcoal depends upon the size of the crank case Enough should be used to bring the casting to the proper temperature in about thirty minutes It is important that the fire be kept under control and the casting heated slowly and only to a medium temperature The upper limit should be 850 deg F The two following methods are given for determining the correct temperature for welding

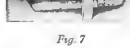

Fig. 7

Fig 8

Fig. 7—A broken aluminum crankcase. Fig 8—The same crankcase lined up for welding.

(1) Cold aluminum gives a metallic sound which becomes duller as the temperature is raised At the temperature required for welding, there is no longer a metallic ring

(2) Heat the casting no more than required to leave a char mark on it when rubbed with a pine stick. Aluminum in this condition is extremely fragile and must be handled with great care

As a welder becomes experienced in handling aluminum, he will at times be able to use a low temperature oil or gas burner for preheating In this case the preheating is done locally along the crack, just ahead of the welding flame, so that the welding heat will not bring on too sudden a rise in temperature and cause further cracking.

The work should be so supported that the under side of the weld is free, in order that the added thickness of metal in the weld may form a slight bulge on the under surface which can afterwards be dressed down if desired A strip of asbestos which has been previously heated to drive out the moisture makes an excellent backing material for the welding of aluminum

There is no danger of metal falling away during the welding, even when the under side is unsupported, unless the weld is excessively wide or the thickness dealt with is very large, or melting carried too far.

At times it is advantageous to use jigs to hold the edges in proper relative positions Where work is done in production, careful study of the matter of design and construction of jigs and fixtures will well repay the effort and expense which may be involved in such a procedure.

As heat is applied to aluminum its temperature increases and the metal expands This fact is very obvious, but it is not sufficient to merely recognize and accept that fact and then dismiss it from further thought It is important to analyze this phenomenon in detail with the object of applying the mechanisms concerned to the actual practice of welding.

The coefficient of expansion is the increase in unit length per degree centigrade increase in metal temperature. The coefficient of expansion increases with increase in temperature and differs for various metals The coefficient of expansion of aluminum is about twice as great as that of iron and one-half as much again as that of copper. That expansion is a definite thing, and that it is not some abstract property which functions only theoritically is shown by the fact that should bars of aluminum, copper and iron, each 1000 ft long, be heated up to 100 deg Centigrade, the iron bar will increase in length about 13 in, the copper bar about 20 in, and the aluminum bar about 27 in In addition to the volumetric or dimensional change due to expansion, there is also the irresistible nature of the force which produces this growth If a bar of metal of proper length to just fit in between two fixed brackets is heated, the bar will buckle due to its tendency to increase in length Expansion operates in all directions If the bar is hindered from increasing its length, it will not assume its new required volume by merely becoming thicker like rubber Of course the bar will become thicker due to expansion, but it will also increase in length The forces which produce this expansion are atomic in nature and will not be denied. Therefore as the metal heats and expands, we must deal both with the new dimensions involved and also with the tremendous forces which produce this growth The reverse action takes place as the metal cools and contracts

Aluminum, copper and iron melt at different temperatures Aluminum melts at about 657 deg C, copper at 1083 deg C and iron at about 1530 deg C Should each of these three bars be heated to their respective melting points, the aluminum will be the shortest of the three. Therefore, not merely the coefficient of expansion must be considered but also the temperature change, because the product of these two determines the total expansion.

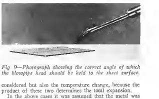

Fig 9—Photograph showing the correct angle of which the blowpipe head should be held to the sheet surface.

In the above cases it was assumed that the metal was heated uniformly In fusion welding, however, the heating is accomplished by applying a torch to one area, therefore the object is not heated uniformly If a torch is applied to the center of a sheet of aluminum, the sheet will be heated at that point and the metal all around the central area will also be heated, but to a decreasing extent, moving farther away from the point of heat application. The metal will tend to expand accordingly, the center growing more than the concentric area farther away. This tendency to grow can be accomplished only by a buckle forming in the sheet If the sheet is perfectly

in choosing from the materials which are in use at the present time.

One principal of fitting design which is applicable to all types of construction is occasioned by the fact that sharp corners are sources of cracks and tears Such corners must be strictly avoided because even small cracks are always dangerous The end of a crack will be a point of high stress concentration when the fitting is loaded and the crack will spread rapidly to proportions which are of sufficient magnitude to cause failure An excellent example of poor design along these lines was incorporated in a recent new design of airplane and is illustrated in Fig 8.

The drag wire lug was formed by cutting two narrow parallel slots in the main fitting and bending up the enclosed strip. The roots of these slots are certain to be the sources of cracks which would ruin the fitting. A good general rule to observe is that all corners should be provided with generous fillets

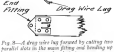

Fig 8—A drag wire lug formed by cutting two parallel slots in the main fitting and bending up the enclosed strip

In this same connection it is well to remember that sheet metal will crack if bent around too short a radius This characteristic is considerably annoying when one is attempting to crowd rivets or bolts into a small space near a bend in the plate The minimum inside radius of bend for heat-treated aluminum alloy sheet, for example, should be about twice the thickness of the sheet when that thickness is less than ⅛-in and the bend is as much as 90 deg. For greater thicknesses the required bend radius increases This radius varies, of course, with different materials and different physical properties and should be determined and standardized by the designer

In fittings which are formed from sheet metal one frequently sees all sorts of curves and reverse curvatures which were incorporated for the purpose of cutting the fitting to its actual minimum permissible size in all places. In most cases of this sort the edges of the fitting could have been cut on more straight lines with very little sacrifice of weight Straight lines can be sheared whereas curves can only be nibbled, ground, stamped, or cut by some equally expensive process It is frequently more economical to make the outline of a fitting of such a shape as will permit it to be cut by shearing and lighten it with drilled holes than to make a complex outline which cannot be sheared

Another important consideration is that of corrosion Much has been written concerning the corrodibility of particular materials so that it is unnecessary to go into detail here In addition to influencing the choice of materials, however, this factor influences the actual physical shape of a fitting Any pockets or crevasses will be seats for the collection of moisture The interior of a hollow fitting will generally be inaccessible for inspection and periodic cleaning and painting, so should be carefully coated and hermetically sealed whenever possible

There is also the fact that thin gauge materials are more seriously injured by corrosion than thicker ones, and there are certain minimum advisable thicknesses because of this Steel tubing of less than .035 wall thickness is never used in the primary structure of an airplane, chiefly because of the corrosion factor

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Technical Reviews

N A C A. Technical Report No 293 Two Practical Methods for the calculation of the Horizontal Tail Area Necessary for a Statically Stable Airplane, by Walter S. Diehl

This report is concerned with the problem of calculation of the horizontal tail area necessary to give a statically stable airplane Two entirely different methods are developed, and reduced to simple formulas easily applied to any design combination Detailed instructions are given for use of the formulas, and all calculations are illustrated by examples The relative importance of the factors influencing stability is also shown.

N A C A Technical Report No 295 The Variation in Engine Power with Altitude Determined from Measurements in Flight with a Hub Dynamometer. By W D Gove.

The rate of change in power of aircraft engines with altitude has been the subject of considerable discussion. Only a small amount of data from direct measurements of the power delivered by airplane engines during flight, however, has been published This report presents the results of direct measurements of the power delivered by a Liberty 12 airplane engine taken with a hub dynamometer at standard altitudes from zero to 13,000 ft Six flights were made with the engine installed in a modified DH-4 airplane The tests were conducted at the Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics

The experimental relation of brake horsepower to altitude is compared with two theoretical relations and with the experimental results, for a second Liberty 12 engine, given in N A C.A. Technical Report No 252 The rate of change in power with altitude of a third Liberty engine, measured with a calibrated propeller, is also given for comparison

The data presented substantiate the theoretical relation of brake horsepower to altitude based on the correction of ground level indicated horsepower, changes in atmospheric temperature and pressure with the subsequent deduction of friction horsepower corrected for altitude. The equation for this relation is

$$\mathrm{B\,HP}_a = \mathrm{B\,HP}_o\left[\left(\frac{P_a}{P_o}\right)\left(\frac{T_o}{T_a}\right)^{\frac{1}{2}}\left(1+\frac{\lambda-\lambda n}{n}\right)-\left(\frac{\lambda-\lambda n}{n}\right)\right]$$

where P is the absolute atmospheric pressure, T is the absolute temperature, n is the mechanical efficiency of the engine at sea level and λ is the ratio of mechanical friction to friction horsepower at sea level. The subscripts $_o$ and $_a$ denote sea level and altitude conditions, respectively.

N. A. C. A Technical Report No 296 Pressure Distribution on PW-9 Wing Models From—18 deg Through 90 deg Angle of Attack By Oscar E Loeser, Jr

Welding Aluminum *and* Its Alloys

By W. M. Dunlap
Metallurgist, Aluminum Company of America

THE purpose of this paper is to supply information on the welding of aluminum and its alloys. A weld as defined by the American Welding Society is "The localized intimate union of metal parts in the plastic or plastic and molten states with the application of mechanical pressure or blows, and in the molten or molten and vapor states without the application of mechanical pressure or blows."

Welding may be classified under three principal processes—forge, pressure, and fusion. The chief difference between these processes is that in forge welding the weld is in general completed by the application of a hammer blow, in pressure welding, by means of mechanical pressure, and in fusion welding, without any mechanical means. The temperature at which the metals are united also differentiates these three processes, for with few exceptions the metals are, in forge welding, in the plastic state, in pressure welding, in the plastic or molten states and in fusion welding, in the molten state. Aluminum and its alloys lend themselves most readily to fusion welding, and this is the type of welding to be discussed in this paper.

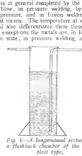

Fig 1—*A longitudinal section of a flashback chamber of the simplest type.*

The term "fusion" is thought to be much more appropriate than "autogeneous," which is sometimes incorrectly used for this type of welding. There are two general classes of fusion welding, the first, arc welding, which is most commonly used in steel work, has not been sufficiently developed for use with aluminum to permit using this process as a commercial application. The second class, torch or gas welding, is used extensively in the aluminum industry.

Among the methods which are employed for joining aluminum or its alloys none is more generally satisfactory than fusion welding with the oxy-hydrogen or oxy-acetylene torch. In the hands of an experienced aluminum welder the process is simple and rapid, and it can be applied to metal of all thicknesses. The resultant joint is not unsightly, and if necessary the weld can be finished off in such a way that it is impossible to detect where the joint exists.

The same types of weld, that is, butt, lap, tee, fillet, etc., are made in aluminum as in any other metal. Some training will be necessary before a welder can turn out consistently reliable results with aluminum. This metal has distinct characteristics of its own which involve a somewhat different technique from that required for steel, cast iron and other metals. However, this special technique is by no means difficult to acquire, for in point of fact, aluminum is one of the most readily weldable of all metals.

Torch welding is applicable both to the manufacture of articles from sheet aluminum and to the repair of aluminum alloy casting. In these two applications, the methods of working are generally the same, though the difference in physical properties may involve slight modifications. Aluminum alloy castings being more brittle than the pure aluminum sheet, the danger of cracking due to expansion and contraction effects is more serious; on the other hand, pure aluminum sheets are normally much thinner than aluminum castings and hence require a more delicate handling of the torch. For both classes of material certain precautions are necessary if reliable welds are to be obtained. In the following paragraphs emphasis will be placed on the principal points to be observed in the welding of aluminum and its alloys.

The apparatus required for the torch welding of aluminum is not different from that required for welding other metals, and consists essentially of a supply of oxygen and hydrogen or acetylene, with reducing valves and safety valves, torches and a series of tips. The oxygen, hydrogen and acetylene is usually obtained from cylinders of compressed gas.

A special warning in connection with the use of oxygen tanks bears repeating many times. DO NOT USE OIL OR GREASE of any kind around oxygen tanks, valves, regulators or gauges. In the presence of oxygen under pressure, oil will catch fire and burn violently. This warning should always be heeded. An operator with greasy hands should not handle tanks of oxygen until his hands have been thoroughly washed and oily or greasy gloves, of course, should never be used.

A regulator, or "reducing valve" as it is sometimes called, is used to reduce the pressure of the gas flowing from the cylinder down to any wanted working pressure, and for delivering the gas to the torch not only at a constant pressure but also in constant volume. The regu-

MANUFACTURERS' SPECIFICATIONS ON AMERICAN C

THE TABLE BELOW IS BELIEVED TO BE ACCURATE BU

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MANUFACTURER	Designation	Price of Plane at Factory	Type	No. of Seats	Make of Engine	Total Rated HP.	Make of Propeller	Span	Wing Area (Sq. Ft.)	Length Overall	Height Overall	Weight Empty (Lb.) With Water If Water Cooled Engine Is Used	Pay Load (Lb.)
Advance Aircraft Co.	Waco 10	$5 635	OBL	3	Sh12	125	M,Hs,SS	30'7"	280	23'9"	9'	1330	370
Advance Aircraft Co.	Waco 10	$2 635*	OBL	3	OX5	90	Hs	30'7"	285	23'6"	9'	1225	360
Advance Aircraft Co.	Waco 10	$2 585*	OBL	3	E	180	M,Hs,SS	30'7"	285	23'6"	9'3"	1508	600
Advance Aircraft Co.	Waco 10	$7 341	OBL	3	J5	200	H,Hs,SS	30'7	285	23'6"	9'3"	1550	590
Aero-Craft Mfg. Co.	Aero-Coupe	$5 000	SBL	3	W	110	F	32'	250	24'	6'0'	1100	600
Alexander Aircraft Corp	Eaglerock A-1		OBL	3	J5	200	—	36'8"	330	24' 11"	9' 11"		—
Alexander Aircraft Corp	Eaglerock A-2	$3 250*	OBL	3	OX5	90		36'6"	330	24' 11"	9' 11"		
Alexander Aircraft Corp	Eaglerock A-4		OBL	3	E	180		36' 6"	330	24' 11"	9' 11"		
American Eagle Aircraft Co		$2 985	OBL	3	OX5	90	E, Hs	30'	330	24' 3"	9' 4"	1227	840
Arrow Aircraft Corp	Arrow-Sport	$2 267	OBL	2	LB	60		25' 0"	170	19'2"	6' 11"	824	
Bach Aircraft Co.	Air Yacht	$31,830	CML	10-12	3Shl 2-pwr	650	2 Sty, SS	52'	412	36.1	9' 6"	3300	
Bellanca Aircraft Corp.	CH	$14 500	CML	6	J5	200	Hs	46'4"	273	26' 9	8 0	1550	2220
Berliner Aircraft Co	CM4	$7 200	OML	3	OX5	90	M Hs	36	215	25'10"	8	1400	
Berliner Aircraft Co	CM5	$8 650	OML	3	J5	200	SS	36'	216	25'10"	9'	1675	
Bird Wing Commer. Airplane Co.	No 6	$2 795	OBL	3	OX5	90	Hs	34' 4"	303	23' 8"	9' 7	1235	650
Boeing Airplane Co	40-B	$24 500	SBL	3	P Wh	400	H M	44'2"	545	33'4"	11'8"	3843	1428
Boeing Airplane Co.	40-C	$22 500	SBL	6	P Ww	400	H M	44'2"	545	33'4"	11'8"	3527	1435
Boeing Airplane Co.	B-1E	$16,500	CBF	6	P Ww	400	H W	37'3"	545	32'9"	12'	3650	730
Boeing Airplane Co	B-1D	$16 000	CBF	4	J5	200		39' 8"	400	30'0"	12'	3442	730
Bourdon Aircraft Corp.	Kitty Hawk		OBL	2	Sh11	90	W	28'	231	21'11"	6'6½"	1110	—
Broese Aircraft Co			CML	6	J5	200	SS	41'	250	27	10'0"	155	
Buhl Aircraft Co	Airsedan-C8A	$13 500	CBL	6	J5	200	SS	42'	334	28	10'	2072	1000
Buhl Aircraft Co.	Airsedan CA-3C	$17 000	CQL	2-4	J5	200	M	39'	240	28'	8'0"	1600	655
Buhl Aircraft Co.	Junior Airsedan	$8 000	CQL	3	W	110	M	36'	240	25'	8'0"	1500	620
Cessna Aircraft Co.	3-120	$5 700	CML	3	A	120	H Hs	40'0"	224	22'0	7 0	1280	480
Cessna Aircraft Co.	6-125	$6 000*	CML	4	Sh12	125	H Hs	40'0"	224	23 9	7 4	1200	700
Cessna Aircraft Co.	4-200	$9 500	CML	4	J5	200	H Hs	40'3"	224	25' 8	7 4	1490	600
Command Aire Inc.	Command-Aire	$2 450*	OBL	3	OX5	90	H	31' 6"	285	24' 0"	8'	1275	370
Crawford M & A Mfg Co	A1	$1 800	OML	2	LR	80	own	30'	150	17 0"	7'	950	
Crown Motor Carriage Co.	B3		OBL	2-3	K-5	100	H	38' 0"	236	21' 3"	6' 5"	850	330
Curtiss-Robertson Airp'ne Mfg Co.	Robin	$4 000	CML	3	OX5	90	Hs	41'	245	25' 3"	7 10"	1465	338
Driggs Aircraft Corp.	Dart II	$1 800	OBL	2	A3	35	Hs	26'	140	19' 5"	6'	450	
G Elias & Bro Inc.	Aircoupe	$3 650	CML	5	A	80	Elias	39' 1½"	192	21'	7'2"	870	518
Fairchild Airplane Mfg Corp	Fairchild 21	$4 250	CML	2	C	80	HW	28	135	22 0"	4 10½	755	
Fairchild Airplane Mfg Corp.	Fairchild 41	$8 950	CML	4	J5	200	Hs	39	254	24 7"	8'0"	2000	
Fairchild Airplane Mfg Corp	Fairchild 71	$10 900	OML	7	P Ww	400	SS	50'	332	32 10½"	9'4"	3000	
Federal Aircraft Corp.	CM-1	$12 500	CM	5	J4B	200	We	37'0"	282	29 3"	9'	2080	630
Fokker Aircraft Corp	Universal	$14 200	CML	5-7	J-5	200	H Hs	47'0"	341	33'	8'6"	2100	1200
Fokker Aircraft Corp.	Super-Univ	$18 340	CML	6-8	P Ww	400	SS	50' 8"	383	36'	9' 11"	2800	1280
Fokker Aircraft Corp	Fokker F 10	$60 000	CML	14	3-P Ww	1260	SS	71'2"	798	46' 8"	12' 0"	7200	2840
Gates-Day Aircraft Corp.	GD-24	$5 200	OBL	3	E	180	H	40'	350	26'	11'	1700	600
Gibbs Aircraft Corp.	Crusader		CBL	4	Sh12	125	Hs	32' 6	240	23'	8'1"		
Hamilton Metalplane Co	H-45	—	CML	8	P Ww	400	H	54' 6"	387	34'8"	9'4"	3300	1100
Hamilton Metalplane Co.	H-47		CML	8	P Wh	500	H	54' 6"	387	34 6"	9 4"	3450	1045
Heath Airplane Co	Parasol	$795	OML	1	H	23	own	33'	94	18'9"	6' 11'	290	
International Aircraft Corp.	F-17	$5 600	OBL	3	OX5	90	H	35'	325	28	9' 0"	1480	820
International Aircraft Corp.	F-18	$12 315	CBL	6	J6	200	SS	37'	358	27' 9"	10' 0"	2300	980
Ireland Aircraft Inc	Neptune	$14 800	CMA	5	J5	200	CR	40	350	31' 5"	11' 0"	2350	780
Irwin Aircraft Co	M T-6	$1 185	OBL	1	170	25	own	20'	105	12' 5"	5' 6"	270	100
Keystone Aircraft Corp	Patrician	$80 000	CML	20	3Cy	1575	SS	90	1000	63'	13	8505	3880
Keystone Aircraft Corp.	Pathfinder		CBL	12	3-J5	600		69-6"	1100	46'		6536	1500
Kinner A. & M. Co	Courier		OML	2	K	100	SS	35'	210	23	7'	815	
Kreider-Reisner Aircraft Inc	Challenger	$2 400*	OBL	3	OX5	90	Hs, H	30' 1"	285	23' 0"	9' 4	1200	415
E M Laird Airplane Co.	Commercial	—	OBL	3	J5	200	SS	34'	300	29' 0"	9' 3"	1550	800
Laird Aircraft Corp.	Whippoorwill		CBL	4	J-5	200	—	35'	341	27	9	1600	
Lincoln Aircraft Co.	Lincoln-Page		OBL	3	OX5	90		32'	300			1200	450
Lockheed Aircraft Co.	Vega		CML	5-7	J5	200	SS We	41'	275	27'6"	8' 6"	1650	1000
Lockheed Aircraft Co	Air Exp		CML	5-7	P Ww	400	SS	41'	275	27' 6"	8' 6"	1850	1000
Loening Aeronautical Engr Corp	Cabin Amphibian	$28,700	CBA	8	Cy	525	SS	45' 8"	517	34 8½"	13'0"	3550	1100
Mahoney-Ryan Aircraft Corp	Ryan B1	$12 200	CML	5	J5	200	H W	42'	290	28' 5"	8'10"	1870	800
Metal Aircraft Co	Flamingo G-1		CML	6-8	P Ww	400	SS	48'	334	30'	9'	2800	—
Mono Aircraft Inc	Monocoupe	$2 675	CML	2	V	60	Hs	30'	136	19'6"	6' 3"	700	
Mohawk Aircraft Corp.	Pinto	$2 775	OML	2	V	60		30'8"	124	22'	6 3"	650	200
Niles Aircraft Co.	Williams		OML	1	Sz	40		26'	108	18	5'0"	440	
Pheasant Aircraft Co Inc	H-10	$3 075	OBL	3	OX5	90	Hs	32' 6"	283	26' 3"	9'	1297	600
Pitcairn Aviation Inc	Mailwing	$13 500	OBL	1-3	J5	200	SS	33'	255	22'10"	8' 10"	1612	600
Pitcairn Aviation Inc.	Super Mailwing		OBL	1-2	J5	200		33'	252	22'10½"	9'3"	1840	
Pitcairn Aviation, Inc	PA-4		OBL	3	OX5	90	Hs	30'	220	21'10"	8'7"	1100	
Prudden Aircraft Corp	S-E-1	$22 500	CML	8	P Ww	400	SS	60'	427	38'	9' 5"	3000	1200
Richmond Airways, Inc.	Sea Hawk		OMF	2	C6	160		45'	317	28'		1700	
Sikorsky Mfg Co.	S-37		CBL	16	2P Wh	1500		100'	1045	45' 6"	16' 6"	8500	4000
Sikorsky Mfg Co	S-38 Amphibian		CQA	10	2P Ww	800	SS H	71' 8"	720	40'3"	13'10"	6000	2210
Simplex Aircraft Corp	Red Arrow	$3,350	CML	2	K5	100	Sty	32' 4"	146	20' 3"	6' 10"	1000	
Sterling Aircraft Co			OBL	2	OX6	90		30'		23'4"	6	1237	
Stearman Aircraft Co.	C-3-K	$8 740	OBL	3	Sh12	125	H Hs	35'-25	260	24'	9'	1285	350
Stearman Aircraft Co.	C-3-B	$8 750	OBL	3	J5	200	H CR	35'-26	600	28	9'	1438	400
Stinson Aircraft Corp	SM-1D	$12 500	CML	6	J5	200	H	45 10"	282	32'	9'0"	2000	1300
Stinson Aircraft Corp	Junior SM-2	$8,950	CML	4	W	110	Wd	41' 8"	236	28' 3"	7' 6"	1310	592
Spartan Aircraft Co	C-3	$5,250	OBL	3	Wal	135		32'	262	23'11"	8'9"	1300	443
Stout Metal Airplane Co	4 AT		CML	12	3J6	600	SS	74	785	49 10"	12' 8"	6100	2700
Swallow Airplane Mfg Co.	Commercial		OBL	3	OX5	90	—	32'	300	24'	8 8"	1470	360
Taylor Bros. Aircraft Co.	Chummy	$3 800	SML	2	K-5	100		34'	170	22	7'6"	950	100
Texas Aero Corp.	Temple		OML		J6	200		30' 4"	225	25' 10"	8' 3"		867
Thaden Metal Aircraft Co.	T-1		CML	7	P Ww	400		53		35	11	2000	
Thunderbird Aircraft Inc.	W-14-O	$2 950*	OBL	3	OX5	90	Sty	31'	270	24' 6"	8' 7"	1431	340
Thunderbird Aircraft Inc.	W 14-H		OBL	3	H	150	Sty	31'	270	24'0	9' 7"	1551	480
Travel Air Mfg Co	2000	$2 850	OBL	3	OX5	90	H Hs	34' 8"	300	24' 2"	9' 0"	1330	350
Travel Air Mfg Co.	4000	$6 100	OBL	3	J5	200	H	34' 8"	290	23' 0"	8' 0"	1600	600
Travel Air Mfg Co.	6000	$13 400	CML	6	J5	200	SS, H	48' 7"	282	30 10½"	10' 6½"	2470	844
Travel Air Mfg Co.	9000		OBL	3	Sh12	125	W	34' 8"	291	24'2"	9'0"	1259	380
Wallace Aircraft Co.	Touroplane	$2 500*	CML	3	A	80	Hs	37'	203	23' 0"	7' 0"	850	320
Whites Aircraft	Brun Bird	$2 180	OBL	3	OX5	90	Hs	33' 1"	310	25' 0"	9' 3"	1000	450
Western Airplane Corp.	King Bird	$2 300	OBL	3	OX6	90	Hs	35'	320	25' 4"	9'	1300	620
Zenith Aircraft Corp	Albatross	$35 000	CML	14	3-Sh12	375	Sty	60'	1062	60'	12' 0"	8000	6500

TYPE.
A—Amphibian
B—Biplane
C—Closed
F—Flying boat
L—Landplane
M—Monoplane
O—Open
Q—Sesquiplane
S—Semi-closed
W—Seaplane

ENGINE. One engine unless stated otherwise.
A—Anzani
C6—Curtiss
Cy—Wright Cyclone
E—Wright Hispano-E
G—Genet
H—Henderson
170—Irwin
J5—Wright Whirlwind
K—Kinner
L—Liberty
LB—Le Blond
LR—LeRhone
OX5—Curtiss
P Wh—Pratt & Whitney Hornet
P Ww—Pratt & Whitney Wasp
SR—Super Rhone
SH—Siemens Halske
Sz—Szekely
V—Velie
Wal—Walter
W—Warner
*—Price without engine

PROPELLER.
CR—Curtiss Reed
H—Hamilton
Hs—Hartzell
M—Metal
Sty—Story
SS—Standard Steel
W—Wood
We—Westinghouse

OMMERCIAL AIRPLANES AND SEAPLANES AS COMPILED BY *AVIATION*

UT *AVIATION* DOES NOT ASSUME RESPONSIBILITY FOR THE FIGURES GIVEN

appear monthly and corrections and suggestions are invited.

Disposable Load (Lb.)	Normal Gross Weight Loaded (Lb.)	Performance With Full Load at Sea Level As Supplied by Manufacturers.						Fuel Capacity in Gallons	Normal Range in Miles	Normal Fuel Consumption at Cruising Speed Gal. Per Hr.	Fuselage Construction	Wing Construction	Are Wings Wired for Lighting?	Type of Control	Brakes	Type of Shock Absorber	Type of Pontoon Provided for	Additional Cost a Seaplane	Dept. of Commerce Type Certificate Number	Performance Figure Guaranteed?	
		High Speed in M.P.H.	Cruising Speed in M.P.H.	Landing Speed in M. P. H.	Climb at Sea Level in F. P. M	Climb to *10'000* in Minutes	Service Ceiling in Feet														
800	2025	107	93	35	..	..	....	37	..	..	Wl-ST	Wd-F	Yes	SPD	Ex.	O-S	EFH	$1,100	20	....	Advance—Waco Siemens
800	2025	96	85	35	.	..	13,000	48	450	8	Wl-ST	Wd-F	Yes	SPD	Ex	O-S	EFH	..	13	...	Advance—Waco OX—5
1092	2000	115	105	40	..	..	15,000	76	..	....	Wl-ST	Wd-F	Yes	SPD	Ex.	O-S	EFH	$1,100	42	...	Advance—Waco Hisso
1050	2600	135	118	40	1200	..	16,000	65	..	12	Wl-ST	Wd-F	Yes	SPD	Ex.	O-S	EFH	$1,100	41	..	Advance—Waco W—J—5
1000	2100	110	100	38	900	.	12,000	44	460	0.0	Wl-ST	Wd-F	Yes	SD	B	Arl	...	$1,000	Apl.	Yes	Aero-Craft—Coupe
....	2491	130	.	39	1080	..	17,900		..	...	Wl-ST	Wd-F		SCD	...	RC	E	...	50	.	Alexander—Eaglerock A-1
...	2442	100	87	34	514	..	11,500	46	435	10.3	Wl-ST	Wd-F	...	SCD	...	RC	E	...	7	Yes	Alexander—Eaglerock A-2
..	2618	121	.	40	840	..	14,700		..	...	Wl-ST	Wd-F	...	SCD	..	RC	E	...	68	...	Alexander—Eaglerock A-3
830	2057	101	85	30	575	45	12,000	42	425	7.0	Wl-ST	Wd-F	Yes	SPD	Ex.	RAR	E	$990	17	Yes	AmericanEagle
450	974	105	..	36	080	..	15,200	..	.	..	Wl-ST	Wd-F	...	S	....	RC	...	....		....	Arrow—Sport
3200	6500	150	110	45	1100	12	18,000	170	500	32	Wd-P	Wd-F	Yes	DeCD	S-B	Hy-C	..	...		Yes	Bach—Air Yacht
3284	5134	128	110	40	650		13,000	92	800	10	Wl-ST	Wd-F	Yes	SCD	Yes	RC	D	...	47	...	Bellanca—CH
900	2300	105	85	41	450	40	13,000	37	400	8	WEST	Wd-F	Ex.	SPD	Ex	O-S	None	....	39	5%	Berliner—CM-4
1025	2700	136	110	45				60	550	12	Wl-ST	Wd-F	Ex.	SPD	B	O-S	None	....	Apl	5%	Berliner—CM-5
1019	2255	90	80	30	400	80	10,000	35	325	9	Wl-ST	Wd-F	Yes	SC PD	Ex.	RC	E	$990	Apl	Yes	Bird Wing—No.5
2536	6079	182	.	57	800	16.5	15,100	140	.	25	Wl-ST	Wd-F	Yes	S	S	O	....	...	27	...	Boeing—40-B
2553	6075	129	..	57	600	25 3	12,000	140	.	20	Wl-ST	Wd-F	Yes	S	S	O	....	...	54	...	Boeing—40-C
1460	4550	115	..	59	1000	18 5	12,000	80		20	Wd	Wd-F	Yes	De	...	....	...	..		...	Boeing—B-1E
1000	3442	95	..	52	.		12,000	40	.		Wd	Wd-F	Yes	DeD	...		...	..	23	...	Boeing—B-1D
....	1888	110	90	40	..		12,000	37.8	..	0.5	Wl-ST	Wd-F	..	SPD	...	RD	....	....	Apl	...	Bourdon Kitty Hawk
1000	2550	120	115	43	900		15,500	80	550	9.5	Wl-ST	Wd-F			...	RC	....			....	Breese
1628	3700	120	95	50	00	45	13,500	70		15	Wl-ST	Wd-F	Yes	SC	Yes	OS	Met	$2,500	33	....	Buhl Airsedan
1400	3200	139	115	45	900	15	14,000	90	700	14	Wl-ST	Wd-F	Yes	SP	Yes	OS	Met	$3,000	46	5%	Buhl Special Airsedan
1000	2500	110	90	40	600	25	11,000	..	600	7	Wl-ST	Wd-F	Yes	SP	Yes	OS	Met	$2,000	Apl	5%	Buhl Junior Airsedan
750	3000	125	110	45-50	1000		..	42	400	10	Wl-ST	Wd-F	Yes	SPD	Ex.	RAR	...	....	Apl	5%	Cessna Aircraft Co.
1030	2280	125	115	45	1000		...	42	400	10	Wl-ST	Wd-F	Yes	SPD	Ex.	RAR	...	....	Apl	5%	Cessna Aircraft Co
1070	2420	150	125	45-50	1400		..	42	400	12	Wl-ST	Wd-PF	Yes	SPD	Ex	RAR	..		Apl	5%	Cessna Aircraft Co.
600	2075	104	85	30	550		10,000		400	..	Wl-ST	Wd-PF	Yes	S	No	RC	E	$1,100	53	.	Command-Aire
450	1400	95	04	47			18,000	40	500	6	ST-Wd	Wd.F	No	D	..	RC	..	...	No	5%	Crawford A1
700	1500	110	90	35	750	45	14,000	27	400	0	Wd	Wd-F	No	SD	No	Grs	..		Apl	Yes	Crown—B3
728	2217	101	85	40	400		11,500	30	607	7	Wl-ST	Wd-FD	Yes	S-PC	No	RAR	..	..	40	5%	Curtiss—Robin
370	820	85	75	46	560		15,000	15	375	3	Wl-ST	Wd-FD	Yes	SC	No	RAR	None	...	15	5%	Driggs—Dart II
564	1334	96	80	25	590	.	10,000	20	400	4	Wl-ST	Wd-F	Yes	SC	No	Elias	None	...	..	...	Elias—Aircoupe
495	1250	105	90	40	700		10,500	20	425	5	Wl-ST	Wd-F	No	SC	Yes	OS	F		Apl	Yes	Fairchild—21
1600	3600	130	104	50	600		12,400	70	600	12	Wl-ST	Wd-F	Yes	SC	Yes	OS	F		Apl	Yes	Fairchild—41
2500	5500	138	110	55	1050		17,500	160	900	21	Wl-ST	Wd-F	Yes	SC	Yes	OS	F		69	Yes	Fairchild—71
1395	3475	125	105	40	..		....	84	750	10	Wl-ST	Wd	Yes	SC	Yes	Arl				...	Federal Aircraft—CM-1
1900	4000	118	98	45	500	40	11,500	76	000	12	Wl-ST	Wd-P	Yes	SCD	Yes	RC	M	$2450	9	...	Atlantic—Fokker Univ.
2200	5000	140	118	42	1000	18	18,000	120	700	20	Wl-ST	Wd-P	Yes	SCD	Yes	RAR	M	$3110	Apl	5%	Atlantic—Super Univ.
4950	11500	148	125	55	1400	10	18,000	286	580	60	Wl-ST	Wd-P	Yes	DeCD	Yes	RAR	...		..	...	Atlantic—Fokker F-10
1300	3000	115	95	35	800	14	16,000	56	000	...	DR-F	Wd-F	Yes	SCP	Ex.	O-S	E	$2500	Apl	5%	Gates—Day—New Standard
....	2400	110	90	45	600		11,500	45	420	...	Wl-ST	Wd-F	Yes	DeD	B	O	...	.	..	...	Gillis—Crusader
2408	5750	135	115	50	950	20	16,000	140	000	21	D-cor.	D-cor.	Yes	De	Yes	Arl	H	$2500		5%	Hamilton—H-45
2300	5760	140	120	55	1000	16	18,000	140	600	23	D-cor	D-cor	Yes	De	Yes	Arl	H	$2500	..	5%	Hamilton—H-47
225	515	70	65	32	200			3.3	120	.	R-ST	Wd-F	No	SC	No	RC	...	...	.	....	Heath—Parasol
620	2100	100	87	35	000		10,500	40	450	...	Wd	Wd-F	Yes	S	Ex	O	..	...	35	....	International—F 17
1550	3750	125	110	40	850		14,000	87	500	..	Wd	Wd-F		S	Std.	O	.	...	Apl	....	International—F-18
1358	3606	95	85	40	050	35	11,000	65	500	12	ST-D	Wd-F	Yes	DeD	No	OC		..	Apl	5%	Ireland—Neptune
300	575	90	75	28	400	65	12,000	8	300	1.7	Wd	Wd-F	Yes	SC	..	RC	W	$175		0%	Irwin—M-T-2
2615	15000	151	130	57	1150		17,400	500	750	...	Wl-ST		Yes	..	Yes	.		...	.	....	Keystone—Patrician
4481	10641	112		57	570	.			500	....	Wl-ST	Wd-F	....	....	.	.e.	...	...	.,	....	Keystone—Pathfinder
550	1465	120	110	35	900		20,000	..	800	7	Wl-ST	Wd-F	....	....	S	Gr	...	...	.	....	Kinner—Courier
811	2000	102		39	546	.	12,000	..	400	..	Wl-ST	Wd-F	Ex.	SD	No	RC	EH	$1,100	19	0% N	Kreider-Reisner—Challenger
		130	10	40	1350	10	....	80	600	..	DT, S	Wd-F		SPA			...	....	.	....	E. M. Laird—Commercial
1000	2650	125	105	40	.	18	....	.	..	..	Wl-ST	Wd-F	Yes	DeD.	Std	RC	...	....	..	....	Laird—Whippoorwill
1000	2200	100	.	35	000			42	500	..	Wl-ST	Wd-F	..	..	...	.	.	....	28	...	Lincoln—Page
1550	3200	135	110	50	1000	18	15,900	100	700	10	W-mon.	Wd-P	Yes	SC	H	RC	E	....	Apl	5%	Lockheed—Vega
1845	3645	167	135	55	1400	10	17,250	100	1000	18	W-mon.	Wd-P	Yes	SC	H	RC	...	....	Apl	5%	Lockheed—Air Express
1950	5900	130	105	55			15,000	140	550	28	Wd-D	Wd-F-D	Yes	DeD	O	RC			34		Loening—Amphibian
1430	3300	126	108	49	1000		10,000	63	700	10-11	Wl-ST	Wd-F		SC	S	Grs	E	$1,800	26	Yes	B. F. Mahoney—Ryan B1
2050	4850	140	120	48	1250	.	....	150	1000	18	Wl-ST,D	D	Yes	DeDC	S	Arl	...		..		Meta—Flamingo
475	1175	90	75	35	700		....	.	..	.	Wl-ST	Wd-F	Yes	S Pl	..	RAR	E		..	..	Mono Aircraft—Monocoupe
500	1350	100	85	35	650	.	10,000	22	350	4.6	Wl-ST	Wd-F	No	S Pl	No	Grs	..	...	95	Yes	Mohawk—Pinto
..		85		30	925	..	.		360	.	Wl-ST	Wd-F	..	SC	Std	RAR	...	...	Apl	...	Niles—William
785	2082	100	90	35	500	25	12,500	38	400	9	Wl-ST	Wd-F	Ex.	SPD	Ex.	RC	EH	$1,000	36	...	Pheasant—H10
770	2512	136	105	45	1600	.	11,000	00	600	..	Wl-ST	Wd-F	Yes	S	Yes	Arl	...	$900	18	5%	Pitcairn—PA-5
1160	3000	126	110	45	.		...	70		....	Wl-ST	Wd-F	Yes	S	...	Arl	...	...	..		Pitcairn—PA-6
785	1950	101	62	45				35	400	....	Wl-ST	Wd-F		S		Ors	...	..			Pitcairn—PA-4
2065	5065	114	96	59	750		12,000	110	540	17	D-cor.	D-cor.	Yes	DeDC	Yes	P	...	..		....	Prudden—S-E-1
1000	2700	95		45				42	..	..	Wd-D	Wd-F		DeCP		.		...		.	Richmond Airways—Sea Hawk
7000	15000	122	112	58	650		15,000	370	790	30	DOR, B	DOR, B		De D	Hy	RDO			Apl	5%	Sikorsky—S37
4000	10000	125	110	55	880	15	19,400	200	500	36	Wd-D	DOR, B	Yes	DeD	...	DOS	WD	.	60	5%	Sikorsky—S38 Amphibion
600	1600	125	110	40	1000	17	16,000	.	1250	5 5	Wl-ST	Wd-F	Yes	S	...	.	...		..	5%	Simplex—Red Arrow
600	1637	104	95	30	.	15 000	..	40	400	....	Wl-ST	Wd-F	..	SD	...	HyC	.				Sterling
865	2150	110	90	38	025		12,000	50	500	7	Wl-ST	Wd-F	Yes	PC	St.	RHy	D	..	Apl	5%	Stearman—C-2-K
962	2400	130	110	41	1000		18,000	65	020	11.8	Wl-ST	Wd-F	Yes	PC	St	RHy	D	$1,200	Apl	5%	Stearman—C-2-B
2100	4500	125	105	56	900		14,000	90	750	11	Wl-ST	Wd-F	Yes	DeD	Std.	Hy	M	$2,500	74	...	Stinson—SM-1-D
990	2500	110	90	46	500		13,500	42	500	7	Wl-ST	Wd-F	Yes	DS	Std.	Hy	...	.	48	5%	Stinson—Junior
850	2150	115	100	37	800	12.8	18,000	60	000	8	Wl-ST	Wd-F	Yes	DS	No	RC	.	.	73	Yes	Spartan—C-3
3800	10000	114	100	55			14,000	235	540	30	D-cor.	D-cor.	Yes	DeD	St	O	..	.	.	...	Stout—Ford—4AT
730	2200	100		35	000		...	36	500		Wl-ST	Wd-F			...	RC	...	...	21	..	Swallow—Commercial
550	1500	110	100	38	850		...	30	500	8	Wl-ST	Wd-F	Yes	SP	....	RAR	...	...	.	Yes	Taylor Bros.—Chummy
..	2250	..		.	.		..	50	..	....	Wl-ST	Wd-F	..	S	....		...	...	..	....	Texas—Temple
2200								120		..	D-cor	D-cor		De	....	Grs				..	Thaden Metal—T-1
815	2248	114	95	40	800	20	15,000	43	440	10	Wl-ST	Wd-F	Yes	SpeD	Ex	R	EH Ex	$1,100	Apl	5%	Thunderbird W14-O
945	2496	135	110	42	1000	16	16,000	00	440	15	Wl-ST	Wd-F	Yes	SpeD	Ex	R	EH Ex	$2,950	Apl	5%	Thunderbird W-14-H
750	2100	100		42			12,000	42	410	8	Wl-ST	Wd-F	Yes	SPC	No	RC	..	...	30	....	Travel Air—*2000*
1000	2600	130		45			20,000	60		12	Wl-ST	Wd-F	Yes	SPC	No	RC	..	.	32	....	Travel—*4000*
1025	4100	128	107	50	700	.	13,500	78	050	12	Wl-ST	Wd-F	Yes	DoD	Yes	O	..	.	Apl	..	Travel Air—*6000*
960	2210	105	.	42		..	....	06	850	....	Wl-ST	Wd-F	Yes	SPC	....	RC	....	....	38	....	Travel Air—Siemens
650	1500	95	82	40	070	37	11,000	28	500	8 20	Wl-ST	Wd-F	Yes	SPD	.	Hy	..	.		...	Wallace—Touroplane
850	1900	97	90	35	600	..	14,000	40	350	8	Wd W1S	Wd-F	No	S		C	E		Apl	5%	Whites—Humming Bird
800	2000	95	85	30	600	20	12,000		500	8	Wl-ST	Wd-F	No	SC D	No	RC	Own	$1,000	No	5%	Western—King Bird
7000	2,000	100	85	35	600	.	20,000	300	1000	20	Wl-ST	Wd-F	Yes	C	Yes	Arl	No	...	..	Yes	Zenith—Albatross

FUSELAGE AND WING CONSTRUCTION
B—Bolted
Cor.—Corrugated
D—Duralumin
F—Fabric cover
Mon—Monocoque
O—Open section
BRAKES.
B—Bendix
Ex—Extra
H—Hydraulic

P—Plywood cover
R—Riveted
S—Steel
T—Tubing
Wd—Wood
Wl—Welded
L—Lockheed
O—Optional
S—Sauzedde
Std—Standard

LIGHTS:
N—Navigation lights

CONTROL:
A—Arens
C—Cables
D—Dual
De—Wheel
P—Push rods
S—Stick
Pl—Pedal

SHOCK ABSORBER
Arl—Aerol
C—Cord
D—Compression
Grs—Gruss
Hy—Hydraulic
O—Oleo

P—Pneumatic
R—Rubber
RAR—Rusco Aero Rings
S—Coil Spring
T—Trombone

PONTOONS
D—Duralumin
E—Edo
F—Fairchild
H—Hamilton
M—All metal
W—Wood
TYPE CERTIFICATE:
Apl—Applied for and is pending
GUARANTEE:
N—New

MANUFACTURERS' SPECIFICATIONS ON ENGINES AVAILABLE FOR COMMERCIAL USE AS COMPILED BY *AVIATION*

THE TABLE BELOW IS BELIEVED TO BE ACCURATE BUT *AVIATION* DOES NOT ASSUME RESPONSIBILITY FOR THE FIGURES GIVEN

This table will appear monthly and corrections and suggestions are invited

MANUFACTURER OR AGENT	Engine	Cooling System	Cylinder Arrangement	No. of Cylinders	No. of Cycles	Propeller Drive	Rated Hp. and R.P.M. at Sea Level	Maximum Hp. and R.P.M. at Sea Level	Weight Dry Without Hub or Starter	Weight Per Rated Hp.	Bore and Stroke (In.)	Compression Ratio	B.M.E.P.	Displacement (Cu. In.)	Frontal Area (Sq. Ft.)	Diameter of Mounting Ring or Distance Between Bearers (In.)	Height or Overall Diameter (In.)	Length Without Starter (In.)	Guaranteed Fuel Consumption at Rated Hp. Lb./Hp./Hr.	Oil Consumption Lb./Hp./Hr.	Valve Mechanism	Cylinder Construction (See Key)	No. Intake Valves Per Cylinder	No. Exhaust Valves Per Cylinder	Make Spark Plugs Supplied With Engine	Type of Ignition	Make Ignition	No. Carburetors	Make Carburetors	Make Starter	Are Exhaust Manifolds Provided	Shipping Weight Crated	Dept. of Commerce License	Cost at Factory
Aircraft Engine Co.	Comet	A	Rad	7	4	D	150-1800				4½x5½										prr	Al. S	1	1		2M	Sc		Sy, E	Be			N	
Allison Engineering Co.	V1410	A	IV-45°	12	4	D	410-1800	430-1900	1000	2.44	4⅝x7	5.8	126	1410		17	46¾	78⅝	.55	.03	ohc	Al. S	1	1	BG	2B	De		Sg^2	Ec			Y	
Allison Engineering Co.	VG1410	A	IV-45°	12	4	G^1	410-1600	430-1900	1125	2.62	4⅝x7	5.3	128	1410		17		85⅛	.55	.03	ohc	Al. S	1	1	BG	2B	De	1	Sg^2	Ec			Y	
Allison Engineering Co.	V1650	W	IV-45°	12	4	D	420-1700	450-1800	885	2.10	5 x7	5.4	122	1650		17	46 7/16	74¼	.53	.025	ohc	Al. S	1	1	BG	2B	De	1	Sg	Ec			Y	
Axelson Machine Co.	Axelson A7R	A	Rad	7	4	D	150-1800		430	2.87	4½x5½	5.0		512			45⅛	35								M	Sc	3	Sg			750	N	
Curtiss Aeroplane & Motor Co.	OX-5	W	V-90°	8	4	D	90-1400		375	4.17	4x5	4.9		502		12⅞			.58	.030	prr	Mo, C	1	1		1M		1	Z		N		Y	
Curtiss Aeroplane & Motor Co.	OXX6	W	V-90°	8	4	D	110-1900		390	3.55	4¼x5	4.9		568		12⅞			.55	.030		Mo. C	1	1		2M			Z		N		Y	
Curtiss Aeroplane & Motor Co.	C-6A	W	L	6	4	D	160-1700	185-1750	420	2.62	4½x6	5.2	133	573		15¾	30	57 15/16	.52	.015	ohc	Al. Al, S	2	2	AC	2M	Sp		Z	U	N	865	Y	
Curtiss Aeroplane & Motor Co.	D12	W	V-60°	12	4	D	435-2300	460-2500	680	1.47	4⅝x6	5.3	133	1145		15¾		56¾	.52	.018	ohc	Al. Al, S	2	2	BG	2M	Sc	1	Sg	Ec	N	1080	Y	
Curtiss Aeroplane & Motor Co.	Conquerer	W	V-60°	12	4	D	600-2400	635-2450	760	1.26	5⅛x6¼	5.8	130	1569		15¾		56¾	.52	.015	ohc	Al. Al. S.	2	2	BG	1M	Sp	2	Z	Ec	N	1060	Y	
Curtiss Aeroplane & Motor Co., Inc.	Geared Conquerer	W	V-60°	12	4	G^2	600-2400	625-2450	850	1.42	5⅛x6¼	5.8	128	1589		15¾		58⅝	.52	.015	ohc	Al. Al, S.	2	2	BG	1M	Sp	2	Sg	Ec	N	1150	Y	
Curtiss Airplane & Motor Co.	Chieftain	A	H	12	4	D	600-2200	815-2200	900	1.50	5⅝x5⅛	5.4	130	1690		23⅜	45¼	51 11/16	.50	.025	ohc	Al. S	2	2	BG	DM	Sc	2	Sg	E	N	1325	Y	
Curtiss Airplane & Motor Co.	Challenger	A	Rad. S.	6	4	D	170-1800	180-1800	420	2.47	5⅛x4⅞	5.2	124	603		19	41¾	35 5/32	.55	.020	prr	Al, S.	1	1	BG	2M	Sc	1	Sg	E	N	850	Y	
Dayton Airplane Engine Co.	Bear	A	L	4	4	D	110-1550	125-1800	375	3.41	4½x7	5.8	118	444		18	39	47⅛	.505	.0175	ohc	Al, Ni	1	1		2M	Sp	1	Z	N	N	550		1600
Hallet Mfg. Co.	H-526	A	Rad	7	4	D	130-1800		425	3.26	4⅜x5	5.2		526		18⅛	46	37			prr	C	1	1	BG	2M	BR	1	Z		N		N	1700
Irwin Aircraft Co.	Irwin 79	A	Rad	4	2	D	20-1700	25-2200	60	3.00	2⅞x2¾	5.0	110	79	2.0	4⅞	28	11	.45	.031	Au	Aa. Aa. S.	1	1	RB	1M	BR	2	Wf		N	100	N	625
Kinner Airplane & Motor Corp.	K-5	A	Rad	5	4	D	75-1725	112-1880	286	2.80	4.25x5.25	5.0		372		14	42				prr	Al. Al, S.	1	1	CH	2M	Sc	1	Sg	H	Y	400	Y	1675
Kimball Aircraft Corp.	Beetle, Model K	A	Rad	7	4	D	135-1850		378	2.77	4½x5¼	5.0	100	585		17	45	37¾			prr	Al, Ni	1	1		2M	Sc	1	Sg	Ec				
Le Blond Aircraft Engine Corp.	Model 60	A	Rad	5	4	D	65-1950	69-1950	230	3.54	4⅛x3¾	5.3	112	250	5.85	21½	32¾	22 5/16	.58	.03	prr	IC	1	1	AC	DM	Sc	1	Sg	Ec	N	460	12	1230
Menasco Motors Co.	B-2 Salmson	A	Rad	9	4	D	260-1500	278-1760	542	2.08	4.92x6.89	5.2					49⅝	38⅜	.42	.025	prr	Al. S	1	1		2M	O	1	Z					3.250
Michigan Screw Co.	Rover	A	LI	4	4	D	55-1800		210	3.81	3⅞x5	5.0		236							prr	-Ni	1	1		2M	Sc	1	Sg	N				
Packard Motor Car Co.	1A-2775	W	X-60°	24	4	D	1200-2600	1300-2700	1500	1.15	5⅜x5	7	150	2775	6.22	14¼	43 1/32	78 1/16	.52	.03	ohc	S	2	2	BG	4B	Sc	4	Sg	O	V		Y	25.000
Packard Motor Car Co.	3A-1500	W	V-60°	12	4	D	600-2500	650-2700	760	1.26	5⅜x5½	5.5	140	1498	4.03	15¾	38 15/64	62 11/32	.52	.015	ohc	S	2	2	BG	2M	Sc	2	Sg	Ae	N	1275	Y	12.000
Packard Motor Car Co.	3A-1500	W	V-60°	12	4	G	600-2500	650-2700	880	1.46	5⅜x5½	5.5	140	1498	4.03	15¾	36 15/64	65	.52	.025	ohc	S	2	2	BG	2B	De	2	Sg	Ae	N	1390	Y	17,875
Packard Motor Car Co.	3A-1500	W	V-60°	12	4	D	600-2500	650-2700	780	1.30	5⅜x5½	5.5	140	1496	4.03	16¼	38⅝	62 11/32	.52	.025	ohc	S	2	2	BG	2M	Sc	2	Sg	Ae	N	1275	Y	12.000
Packard Motor Car Co.	3A-2500	W	V-60°	12	4	D	800-2000	835-2100	1160	1.45	6⅜x6½	5.7	135	2490	4.8	18¼	36⅛	69¾	.52	.015	ohc	S	2	2	BG	2M	Sc	2	Sg	Ae	N	2150	Y	15.625
Packard Motor Car Co.	3A-2500	W	V-60°	12	4	G	800-2000	835-2100	1380	1.72	6⅜x6½	5.7	135	2490	5.1	16¼	36⅛	76½	.52	.015	ohc	S	2	1	BG	2B	De	2	Sg	Ae	N	2340	Y	19,375
Pratt & Whitney Aircraft Co.	Wasp	A	Rad	9	4	D	400-1900		670	1.67	5x5¾	5.2	124	1344		23⅜		43⅜	.55	.035	prr	Al. S	1	1	BG	2M	Sc	1	Sg		N	1150	Y	
Pratt & Whitney Aircraft Co.	Hornet	A	Rad	9	4	D	500-1900		760	1.52	6⅛x6⅜	5.0	123.5	1690		23⅜		44⅜	.55	.035	prr	Al. S	1	1	BG	2M	Sc	1	Sg		N	1325	Y	
Pratt & Whitney Aircraft Co.	Geared Hornet	A	Rad	9	4	G2	500-1900		835		6⅛x6⅜	5.0	123.5	1691		23⅜		48¾	.55	0.35	prr	Al, S	1	1	BG	2M	Sc	1	Sg		N		Y	
Quick Motors Co.	Quick-Radial	A	Rad	9	4	D	125-1450		325	2.6	4.13x5.81	5		867		19⅝	85	86			prr	Al, S	1	1	CH	1M	Sc	1	Z					1750
Siemens & Halske A.G.*	Siemens Sh 13	A	Rad	5	4	D	80-1750		246	3.01	4.13x4.72	5.3		317		14	39⅝	34	.52	.022	prr	Al, S	1	1	O	2M	O	1	Sm	O	Y	693	Ex	2,300
Siemens & Halske A.G.*	Siemens Sh 14	A	Rad	7	4	D	115-1750		308	2.65	4.13x4.72	5.3		443		14	39⅝	32	.52	.022	prr	Al. S	1	1	O	2M	O	2	Sm	O	Y	726	Ex	2.650
Siemens & Halske A.G.*	Siemens Sh 12	A	Rad	9	4	D	125-1750		362	3.05	3.94x4.72	5.3		517		14.6	40½	32	.52	.022	prr	Al. S	1	1	O	2M	O	2	Sm	O	Y	800	Ex	2.970
Spartan Aircraft Co.	Walter 5	A	Rad	5	4	D	70-1600		225	3.21	4.13x4.72	4.4	112	317		11.35	37	27.5	.60	.028	prr	Al. S	1	1	AC	2M	Sc	1	So		Y	500	Y	1.885
Spartan Aircraft Co.	Walter 7	A	Rad	7	4	D	95-1600		280	2.95	4.13x4.72	4.4	108	444		12.8	37	28.5	.49	.026	prr	Al. S	1	1	AC	2M	Sc	1	Z		Y	650	Y	2,355
Spartan Aircraft Co.	Walter 9	A	Rad	9	4	D	135-1750		352	2.59	4.13x4.72	4.4	112	572		14.56	39	33.5	.49	.026	prr	Al, S	1	1	AC	2M	So	1	DuZ		Y	670	Y	2,940
Szekely, O. E., Corp.	SR-3	A	Rad	3	4	D	40-1800	43.6-1900	148	3.7	4⅛x4¾	4.8	100	191	2.8	9⅛		23¾	.57	.030	prr	C	1	1		2M	BR	1	Z	N	N	205		765
Tips & Smith, Inc.†	Super-Rhone	A	Rad	9	4	D	125-1480	133-1850	315	2.52	4⅝x5⅝	5.2		867	4.75	11		39	.81	.036	prr	-. S. C.	1	1	Sp	1M	Dx	1	Z			400	N	2.250
Velie Motors Corp.	Velie M5	A	Rad	5	4	D	45-1750		210	4.66	4⅛x3¼	5.2		250		12¾	32	27	.55	.028	prr	Al, S	1	1	AC	2M	Sc	1	Z	Ec	Y	420	Y	1.050
Warner Aircraft Corp.	Scarab	A	Rad	7	4	D	110-1850	120-1925	270	2.45	4¼x4¼	5.2	112	422		17	35½	27½	.50	.01	prr	Al. S	1	1	AC	2M	So	1	Sg		N			2.485
Wright Aeronautical Corp.	Whirlwind J5	A	Rad	9	4	D	200-1800	225-2000	500	2.50	4½x5½	5.2	126	766		19¼	45	33¾	.53	.035	prr	Al. S	1	1	AC	2M	Sc	1	Sg		N	1000	Y	4.980
Wright Aeronautical Corp.	Cyclone R1750	A	Rad	9	4	D	525-1900	560-2000	760	1.52	x6⅞	5.0	130	1753		23⅜	53⅝	40⅝	.55	.035	prr	Al. S	1	1	BG	2M	Sc	1	Sg		N	1530	Y	

*—Engines of foreign manufacture
†—rebuilt
a—applied for
A—Air cooled
Aa—Aluminum alloy
Ae—Aeromarine
Al—Aluminum
AS—Anzani or Scintilla
Au—Automatic
B—Battery ignition
BR—Robert Bosch
Be—Scintilla booster magneto

C—Cast iron
Ch—Champion
Cylinder Construction
first—head
second—walls or waterjacket
third—sleeve, if any
D—Direct
De—Delco
Du—Duplex
Dx—Dixie
DM—Dual Magneto
Ec—Eclipse

E—Ensign
Ex—Extra
G—Geared
G^1—5:3 epicyclic gear
G^2—2:1 reduction gear
G.E.—General Electric
H—Hexagonal
I—Inverted
Ic—Cast Iron
L—Cylinders in line
Mo—Monel
M—Magneto

Ni—Nickle Iron
N—No
O—Own
ohc—Overhead cam
prr—Push rods and rocker arms
Rad—Radial
Rad S—Staggered Radial
Sc—Scintilla
Sg—Stromberg
Sg^1—Stromberg NA-U5 duplex
Sg^2—Stromberg NAS-6E

Sm—Sum
So—Solex
Sp—Splitdorf
S—Steel
U—U.S.L. Electric
V—Vee
W—Water cooled
Wf—Winfield
X—Extra
Y—Yes
Z—Zenith

lators work with a diaphragm-controlled movement and are all very much alike The diaphragm may be made of metal or special rubber composition The gas enters the body of the regulator through a small nozzle, that closes when the regulator valve is caused to press against a composition disk or seat and exerts pressure outward on the diaphragm, an opposite pressure is exerted on the other side of the diaphragm by a wire spring Thus pressure is regulated by an adjusting screw When the adjusting screw is turned in it moves the disk seat away from the nozzle (in some regulators the seat is stationary and the nozzle is moved away) and permits the gas to enter the regulator, but as the gas pressure builds up on the diaphragm the disk seat is forced back against the nozzle and the gas passage is closed for a moment and then this action takes place over and over again as long as the torch is being used Hence, a constant balance is struck. The regulator can be set to deliver any desired available pressure by merely turning the adjusting screw in or out a variable number of turns

It is evident that the cylinder valve should never be opened while the adjusting screw is turned in, that is, while the seat is away from the nozzle, as all of the pressure in the cylinder would be suddenly transmitted against the diaphragm and the valve seat would be forced against the nozzle with such a sudden impact as to either break the disk or rupture the diaphragm The composition of this disk seat is an important matter Hard rubber, horn, casenite, galalith, bakelite, etc, is used with success. The seat should be soft enough to take an impression of the nozzle and thus seat tightly, yet not so soft that the nozzle will cut it On the other hand it should be sufficiently hard and tough so that it will not be marred easily by grit that finds its way into the inside of the regulator, but not so hard that it is brittle and easily broken The diaphragm is composed of either a highly tempered non-rusting metal alloy or of rubberized fabric The former has the advantage of long life and non-inflammability with the disadvantage of being less sensitive while the latter has a shorter life but is mort flexible and sensitive and can easily be replaced

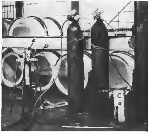


Fig. 2—A complete assembly of welding apparatus

The pressure regulator is an excellent flashback prevention device. Very rarely does a flashback pass through a pressure regulator. However, flashback chambers, which are devices to prevent the propagation of flame through the pipe lines, should be provided They generally employ a water seal, the incoming gas bubbling up through the water In case of a flashback the water prevents the further propagation of the flame.

A longitudinal section of a flashback chamber of the simplest type is shown in Fig 1. Fig 2 shows a complete assembly of welding apparatus. The oxygen container is shown at A; hydrogen container at B, flashback chamber at C, torch at D, flux container at E.

A welding torch consists of two tubes, usually independent although sometimes one within the other, one for oxygen and the other for the combustible gas. On one end of each of these tubes is provided a hose connection, a control valve, and a grip In "head" and "tip mixing" torches, the tubes at their other end are silver soldered or mechanically assembled into a head in which the tip is mounted Some "handle mixing" torches are so designed as to eliminate the head, the tip assuming the form of a bent tube which is mechanically connected into the grip or handle

One of the most important factors to be considered in the selection of a torch is its relative freedom from flashbacks. The Bureau of Standards has made an extended study of these phenomena and the results were published in a paper by R S. Johnson entitled "An Investigation of Oxy-acetylene Welding and Cutting Blow-pipes," presented before the American Society of Mechanical Engineers, May 13, 1921.

Selection of Tip Size Important

The selection of the correct size of torch tip for any particular work is practically a matter of experience. The tables given are merely a guide for the inexperienced welder, since the size of the tip must depend greatly upon the shape and size of the object to be welded, as well as upon the thickness The welding of a large tank of aluminum will require a larger tip than the welding of a small piece of bar of equal thickness, because the larger article has a larger capacity for heat and a larger radiating surface. Much of the heat applied to the edges of the metal to be welded escapes by conduction to remote parts of the object, where it is absorbed in raising the temperature, and part is radiated away to the air The tip must be of sufficient size to melt the edges in spite of this continuous draining away of heat. The size of the tip will also depend to some extent upon the skill of the welder, a quick worker will be able to use a large tip which in the hands of a slower and less experienced man would result in overheating and the formation of holes. Table I gives the approximate size of tip and the gas pressure to be used when welding aluminum

Table I

OXY HYDROGEN

Metal Thickness B&S Gauge	Size of orifice in tip	Oxygen Pressure	Hydrogen Pressure
26 to 18	0.062 in.	1 lb	2 lb
16 to 14	0.078 in.	1 lb	2 lb.
12 to 10	0.093 in.	2 lb	4 lb.
1/8 in to 1/4 in	0.109 in.	4 lb	8 lb.
5/16 in. to 3/8 in.	0.125 in	8 lb	12 lb.

OXY-ACETYLENE

Metal Thickness	No Tip	Size of orifice in tip	Oxygen Pressure	Acetylene Pressure
24 ga to 18 ga	1	0.031 in	1 lb	2 lb
16 ga to 14 ga	2	0.042 in	1 lb.	2 lb
12 ga to 10 ga	3	0.051 in	8 lb.	6 lb
1/8 in to 3/16 in	4	0.062 in	12 lb.	8 lb.
1/4 in	5	0.074 in	20 lb.	8 lb
5/16 in	6	0.084 in	25 lb	8 lb.
3/8 in. to 5/8 in	7	0.095 in	25 lb.	8 lb

To light the torch open the hydrogen or acetylene needle valve, which is the lower valve on the torch, and light the gas with the spark ignitor. Avoid using matches or an open flame. When extinguishing the torch the

oxygen control valve is always shut off before the hydrogen or acetylene control valve to avoid the possibility of burning up the torch tip if it is too hot

In practice it is frequently found advisable, if regulators are not located near the work, to shut off both regulators at the same time, and when ceasing welding altogether, also the cylinder or pipe line-valves When the foregoing is done, the torch valves should be first closed to prevent a waste of fuel and possible dangerous escape of gas The torch valves should subsequently be opened for a few seconds to permit escape of gas in hose and torch, and closed again prior to putting torch away.

It is preferable to use any oxy-hydrogen flame whenever it will supply sufficient heat The oxy-hydrogen flame produces a cleaner and more satisfactory joint and supplies sufficient heat for welding metal up to ⅜ in. in thickness As indicated in the table, a larger tip is used for hydrogen than for acetylene on a given gauge of sheet

Whether using hydrogen or acetylene, the torch should be carefully adjusted to show a neutral flame, as this gives the best speed and economy, as well as a cleaner and sounder weld. The oxy-hydrogen flame is neutral when the volumes of the two gases issuing from the tip of the torch are just balanced If there is an excess of oxygen, the flame will be rather small and will have a very short small cone at the tip of the torch With an excess of hydrogen the flame is long and ragged and there is no defined cone at the center. The neutral flame, in which the mixture of the two gases is just right, has a well defined jet or blue cone in the center of the large flame

Four distinct flames are possible with an oxy-acetylene welding torch The first or acetylene flame is intensely white, of large volume and smoky at its outer end. It is secured by lighting the acetylene gas which burns with the oxygen of the air

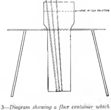


Fig 3—Diagram showing a flux container which can be made easily from a three inch pipe

The second or carbonizing flame is secured by opening the oxygen control valve, thus obtaining better combustion of the acetylene as indicated by the absence of soot There is a small intensely white cone close to the tip surrounded by another white cone, both being clearly visible to the eye Outside of these two cones is a flame which is nearly colorless and of large volume

The third or neutral flame is secured by reducing the amount of acetylene until only one white cone is visible Outside of this cone is a nearly colorless flame of large volume. This flame should be used for welding It is not only the hottest flame, but it prevents excessive oxidation of the molten metal by providing a reducing flame envelope

The fourth or oxidizing flame is obtained by still further reducing the acetylene. The cone is shorter than that of the neutral flame Proper regulation for welding is secured when the flame has one cone with as large dimensions as possible To readjust the welding flame under practical conditions it is best to increase the supply of acetylene until two cones appear, then decrease it until only one is visible.

The various flames have characteristic sounds which the welder should note The sound of the neutral flame is sharper than that of the carbonizing flame but not as shrill as the oxidizing flame In the Bureau of Standard's tests of torches already referred to, it was found that most torches would not maintain constantly a neutral flame under practical welding conditions and that most operators, due to the personal equation, have a tendency to adjust the flame oxidizing

Oxide Film Must Be Removed

All aluminum is coated with a thin film of aluminum oxide which prevents the easy coalescing of the two surfaces of molten metal The production of a sound weld in aluminum necessitates the removal of this oxide film. This obstructing film can be broken up mechanically by manipulation of the welding wire In breaking up the oxide film by this process, which is known as "puddling," the welder, as he proceeds, stirs continuously the molten bath with the welding stick or an iron wire In this way he breaks up the oxide film and allows the metal to coalesce, and at the same time he scrapes the oxide to the surface This method is not a satisfactory one because it is difficult to completely remove the oxide from the bath by puddling and there is considerable risk of oxide inclusions in the solidified metal making an unsound weld It would be too strong to state that it is impossible to obtain a satisfactory weld by this method, but the quality of the weld depends so greatly upon the dexterity of the welder that it would be unsafe to rely upon the process for important work where the strength required is considerable. Apart from this, the method is slow, and therefore costly in gas and labor

The most effective method of removing the oxide is by the use of a flux which has the ability to dissolve the aluminum oxide so that coalescence may occur A satisfactory flux for the welding of aluminum must have the following characteristics:

(1) It must melt at a suitable temperature below the melting point of aluminum

(2) When molten, it must have the ability to dissolve aluminum oxide very quickly

(3) The dissolving capacity of the flux must be sufficient to take care of all of the oxide which might happen to be present

(4) The molten flux, with the oxide dissolved in it, must have a specific gravity less than that of the molten aluminum and the difference must be sufficient so that the flux will quickly and readily come to the surface of the molten metal, thus removing the oxide from the weld

(5) The flux must be stable under the temperatures employed

(6) It must not deteriorate with time, nor must it be too deliquescent

Fluxes filling the above requirements are prepared by a number of reputable manufacturers The Aluminum

Company of America markets a flux for welding aluminum and its alloys known as "#22 Welding Flux."

A satisfactory way to use the flux is to moisten it with water to the consistency of a thin paste A very convenient flux container is made from a piece of three inch pipe as shown in Figure 3 An aluminum, brass or glass flux container should be used Iron is likely to cause contamination by chemical reaction with the flux A day's supply of the flux and water solution should be made up each morning If any of the solution is left in the container over night, it should be thoroughly broken up and stirred next morning, as it tends to lump and crystallize upon standing The flux is made slightly hygroscopic to prevent it from drying out and blowing off the seam ahead of the welding torch Due to this slightly hygroscopic condition the dry flux, if left exposed to the atmosphere, may deteriorate. The dry flux is quite stable if the container is kept closed.

If a welding wire is used the wire is dipped into the flux solution, or if no fillet metal is used, the flux is applied to the joint by means of a small paint brush In this manner, the flux is supplied to the weld where, when and in the quantities required

Choice of Welding Metal Important

Of utmost importance is the selection of the proper welding metal The use of a welding rod or feeding stick is necessary with all but the thinnest sheet Commercially pure aluminum (2S) and aluminum-manganese alloy (3S) should be welded with a pure aluminum welding stick For welding the strong aluminum alloys (17S, 25S and 51S) a five per cent silicon welding stick is recommended However, a welding stick of the same composition as the alloy to be welded will give perfectly satisfactory results if proper allowance may be and is made for expansion and contraction. The silicon welding alloy has a relatively slight solidification contraction and on account of its having a lower melting point than the base metal, it remains molten longer and fills in the voids caused by the solidification contraction of the base metal in the same way that a gate fills in the voids of a casting This means that the stresses due to contraction which might otherwise cause incipient cracking in the base metal shift their effects to the metal supplied in welding This metal which is noteworthy for its freedom from hot shortness, which probably means ductility at temperatures just under the melting point, as well as strength at these temperatures, will stand the stresses without the development of cracks There is necessity for caution in one respect when using a five per cent. silicon alloy welding stick. If the welded articles are to be subjected to a high temperature or "solution" heat treatment after welding, it will be necessary to recognize the fact that this amount of silicon lowers the safe temperature to which some of the strong alloys may be heat treated Whether the original material is 51S, 25S, 17S or aluminum-copper alloy, it will be safe to use heat treating temperatures up to about 940 deg F. even when the five per cent silicon alloy is used for welding.

The sizes of welding wire recommended for aluminum and aluminum alloys are given in Table II.

Table II

Thickness to be welded B&S Ga	Inches	Welding Wire Diameter Inches
Up to 18	Up to 0.040	0.080
18 to 16	0.064 to 0.051	0.092
16 to 14	0.051 to 0.064	0.104
14 to 12	0.064 to 0.081	0.116
12 to 10	0.081 to 0.102	0.128
10 to 8	0.102 to 0.128	0.144
8 to 6	0.128 to 0.162	0.160
6 to 4	0.162 to 0.204	0.176
4 to 2	0.204 to 0.258	0.192
2 to 00	0.258 to 0.365	0.212

Light aluminum sheet (0.050 and lighter) is usually flanged in preparation for welding as in Fig 4 The flange should be about the same height as the thickness of the sheet or just a little higher The joint is made by holding the two upstanding edges together and melting these down For such work as this no welding wire is required Beveling is unnecessary for light sheet

Heavier sheet can be beveled as is usual with steel plate However, it is easier to obtain full penetration by notching the sheet as shown in Figures 5 and 6 The edges of the sheet are cut through the entire thickness, the notches being about as deep as the thickness of the material, and about one-fourth inch apart In welding, the edges are butted close together By preparing the edges in this manner, the flux works down for the full thickness of the material, and considerable welding rod is saved There is less chance of "burning through" and the notches act also as little expansion joints, minimizing local distortion

Particular care is needed when preparing the broken edges of an aluminum casting for welding, since these are occasionally porous and may contain absorbed oils, which, if not removed, will cause blow-holes in the weld A good plan is to heat the edges before beginning to weld, when the absorbed grease will be sweated out and can be wiped off Perhaps the best cleaning mediums are a wire scratch brush and some gasoline Not only the edges to be welded, but also the adjacent surfaces above and below should be cleaned with the scratch brush and washed in gasoline.

Aluminum sheet ⅜ in thick and thicker should be preheated Preheating will limit the consumption of oxygen and acetylene to that required for the actual melting of the seam Furthermore, preheating will tend to prevent distortion If the base metal for some distance on either side of the seam is maintained at a temperature

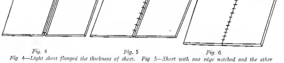


Fig 4 *Fig. 5* *Fig 6*

Fig 4—Light sheet flanged the thickness of sheet. Fig 5—Sheet with one edge notched and the other beveled at 45 deg Fig 6—Plate with edges notched

tensile strength of the plate cross section instead of shear strength

The distance between rivets along a line which makes an acute angle with the line of load application may be computed by combining the shear and tensile strength calculations

The calculated permissible rivet spacing is often less than that which is practical from other considerations. There must always be room to head the rivets properly and this fact suggests a standard minimum spacing, for the smaller sizes, of three times the rivet diameter

An interesting example of riveted joint failure is shown in the photograph of Fig 6 These specimens were fractured by applying a tensile load at the ends They were made primarily to discover the difference, if any, in tensile strength of aluminum alloy sheet when pulled parallel to the grain and at right angles to the grain Although no appreciable difference in ultimate strength was found, a very interesting variation in type of fracture was noted An examination of the photograph will disclose that the same joint failed

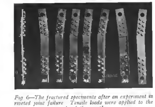


Fig 6—The fractured specimens after an experiment in riveted joint failure Tensile loads were applied to the ends of the samples

1 Through the first screw and first rivet holes,
2. Through the first and second screws and the first rivet holes, and
3 Through the first screw and first and second rivet holes

These variations did not seem to depend upon the grain direction, caused by the direction of rolling the sheet, and the failure occurred at approximately the same loading per sq in in all cases

Another point that occurs to mind is particularly applicable to joints which are formed with iron rivets and aluminum alloy plates Rivet heading, especially when accomplished by slow squeezing, tends to expand the body of the rivet The force thus generated is quite large and will actually split the sheet in which the rivet is inserted if that sheet is too weak Experience is the only possible teacher in this case as the expanding force is impossible to calculate. Before any large amount of money is invested in a fitting which might be ruined by this phenomena it would be best to make a simple test to determine the minimum thickness and spacing permissible under the particular circumstances This peculiarity also has a determining effect sometimes upon the allowable distance from a rivet to the edge of the plate

Parts are occasionally joined by brazing but this is mostly unsatisfactory A good brazed joint, when acting in shear, will develop considerable static strength (about 10000 lb per sq in. of braze) Such a joint is difficult to obtain, however, and there is no way of inspecting the finished joint so as to determine the effectiveness of the brazing In addition it does not appear to have any appreciable tensile strength and there is some doubt about the effects of repeated loads so that this type of construction is generally frowned upon

Solder is frequently used to seal joints against corrosion but is of no use from the standpoint of strength A soldered joint in shear will carry an appreciable static load because its failure usually lags behind the rate of application of load Under repeated loads, however, it rapidly breaks down completely and fails at very small repeated loads

Castings are very useful as fittings, particularly those cast from aluminum alloy and heat-treated This material casts very well and has a high ratio of strength to weight Such material must be handled rather carefully to insure reliable results In the first place there is always the fact that castings are not accurately made Shrinkage and the shifting of cores makes accuracy almost impossible. There is also the ever-present danger of blowholes even in excellent casting material Another danger occurs when the piece incorporates two or more parts of widely different thicknesses. The illustration in Fig 7 will clarify this idea. The difference in rate of cooling and shrinkage between the thick base *A* and the thin piece *B* strains and weakens joint *C* to a material extent The fundamentals of aluminum alloy cast fittings are somewhat as follows.

Provide a minimum thickness of 3/16-in at any point to allow for casting inaccuracies, reduce the opportunities for hidden blowholes to a minimum, and avoid joining two sections of widely different thicknesses

Another common rule which is strictly followed in any type of casting and is consequently well known, is the provision of ample fillets at all corners

Cast bronze, especially manganese bronze, would seem to be particularly well fitted to certain types of construction because of its non-corrodibility and non-magnetic properties It can be made to develop a tensile strength as high as 65000 lb per sq in, which somewhat compensates the fact that it is slightly heavier than steel It cannot be used in conjunction with aluminum alloy, however, because it hastens the corrosion of the aluminum alloy to a very marked degree.

Forged fittings will undoubtedly be more widely used as soon as production becomes large enough to bring their cost within reason Cost seems to be the only detrimental factor here because aluminum alloy, some bronzes, and some alloy steels will produce tough and dependable forgings which are much neater in appearance than the present usual type.

Fig. 7—Illustration of a casting incorporating two or more parts of widely different thickness

Chrome-nickel and chrome-vanadium steel forgings are being widely used for important parts of aircraft engines and their introduction into airplane structure will undoubtedly be only a matter of time

The entire subject of materials and methods of construction for aircraft is one which merits a great deal of study. We have only commenced to experiment with a few of the numberless possibilities. A discussion of these possibilities is without the scope of this article but the few points noted above will serve to assist the designer

flat and at a uniform temperature before heat is applied, the buckle will rise toward the flame. The sheet will not buckle downward away from the flame and this is due to the fact that the surface nearest the flame is the hottest. A temperature gradient is set up through the thickness of the sheet and since the top surface must expand more than the bottom, due to this gradient, the sheet will buckle upward toward the flame. This is a very important detail in connection with welding sheet because some of the major troubles and difficulties with which a welder is concerned are due to warping and buckling of the sheets The above are the underlying principles governing buckling and warping

After completion of the weld all the heat which has been put into the work must be dissipated When the metal cools the processes described above will be reversed, in other words, where there has been expansion there will now be contraction and the net volume changes and forces involved will theoretically be equal in amount, though opposite in direction Care must therefore be exercised in practice that the net result will be zero If the dimensions cannot come back to what they were originally the work will be buckled and the weld will be severely strained The weld is made while the metal is at an elevated temperature and after expansion has taken place, consequently on cooling down to normal temperature the weld resists the metal's returning to its exact original volume. This is a natural phenomenon and cannot be altered, but the distortion or buckling caused by expansion and contraction can be minimized, localized and to some extent controlled. In welding a fitting to a flat panel it is customary to put an emboss in the panel that is a little larger than the fitting to be welded This has a tendency to localize the buckling in the area of the emboss and minimize the buckling in the panel itself

In welding, the difficulties due to contraction during cooling are increased, since the heating is intensely localized Therefore the repair of an aluminum casting, in which the danger of cracking is great, due to the hot-shortness of the metal, is not to be undertaken without a reasonable degree of knowledge and a large degree of common sense Many an expensive casting has been ruined by attempts at repair by self-confident but uninformed amateurs, whereas a specialist in the process can rebuild a crank case equal in appearance and strength to a new casting from a mass of broken parts seemingly ready for the scrap heap

Working Speed Greater Than With Steel

In the welding of aluminum one of the main points in which the process differs from that of steel is in speed of working The speed is very much greater than with steel, and the movement along the seam becomes more rapid as the metal becomes heated

The welding rod is held loosely in the fingers of the left hand, and it is kept in a direct line with the weld. The torch flame is directed centrally so that it melts simultaneously both the edges of the sheet to be welded and also the end of the welding rod Both sides of the weld must be heated equally so that the edges will melt at the same instant, otherwise a bulky and uneven weld will result It is also important when starting that the two edges should commence to melt before any filling material is melted The welder quickly learns to judge the correct instant to commence running up the seam If the torch is kept at an angle of about 30 deg to the surface of the sheet (Fig 9) it will prevent too rapid melting of the metal in a restricted area, and thus avoid melting holes through the sheet By holding the torch at this angle the outer cone of the flame will envelope the metal well ahead of the point of welding, and so will make welding progress more rapidly Care must be taken that the weld penetrate the full thickness of the sheet However, the torch must not be stopped in any one position for a sufficient length of time to melt holes through the sheet, neither should the inner cone of the flame be allowed to come into contact with the metal The operator should watch the metal carefully for signs of melting, and fuse the weld metal thoroughly with the molten metal from the sheet. It is not possible to determine the melting point by the color because aluminum does not change color through the entire heat range used in welding That is, it does not become red hot, but maintains its characteristic silvery white color even in the fluid state.

Progressive Tack Welding Necessary

The assembly of parts before welding is gone about as in welding steel sheet of the same thickness Long seams should be tack welded progressively from end to end at intervals of three or four inches in order to prevent the edges slipping by each other. Intermittent tack welding produces an unsightly weld and is likely to cause cracks. After tacking, the flame of the torch is played upon both edges of the pieces simultaneously, causing them to melt, and, the oxide being removed by the flux, the molten edges flow together and coalesce Only a very small part of the metal is melted at any one time, so that the molten metal is prevented by surface tension from dropping away. The welder progresses rapidly along the seam, the edges melting under the torch and solidifying almost immediately as the torch passes on. In welding long seams, if pronounced buckling starts by the metal shrinking in or out, it should be straightened by hammering before proceeding further with the welding When a welding rod is used, the tip of the rod should be held in the flame near the metal Metal from the welding rod is flowed into the weld by the flame as the heat in the puddle alone is not sufficient to melt the rod The welder should make sure that the added metal fuses thoroughly with the base metal The weld should be built up 1/16 to ⅛ in. above the surface of the base metal. The weld should be completed as rapidly as is consistent with good workmanship, using a flame of minimum size.

When the joint is completed every portion of the seam will have been melted and solidified again, hence the metal in the weld is in the cast state.

In the case of hard rolled pure aluminum sheet the zones on either side of the weld usually constitute the weakest part, for the thickness at the weld itself can be increased by the addition of welding rod, and the weakness of the cast structure at the weld counteracted by this means The annealed zones on either side of the weld remain, however, so that whatever the original temper of the metal the final strength will be about 14,000 lb per sq in.

Simple alloys are readily welded in the same manner as commercially pure aluminum sheet, and the same sort of conditions apply. Thus, hard rolled sheets, after welding, will exhibit the three zones

(1) Cast metal at the weld

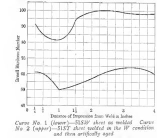
(2) Softened regions on either side

(3) The remote parts of the metal which have not been affected by the heat of welding

With heat treated alloys such as 17S, 25S and 51S it might be expected that if the whole object is submitted to heat treatment after welding the original strength could be regained However, these alloys in the cast

condition are much less susceptible to heat treatment than the wrought metal Therefore, while the partially annealed zones on either side of the weld would respond to heat treatment, the cast metal in the weld would be much less affected.

In the case of heat treated alloys, the area on either side of the weld is not completely annealed A series of Brinell impressions was made on welded specimens of



Curve No 1 (lower)—51SW sheet as welded Curve No 2 (upper)—51ST sheet welded in the W condition and then artifically aged

0 064 in heat treated 51S sheet to determine to what extent the heat of welding affected the temper of the sheet The results of this survey are shown graphically in curves No 1 and No 2 Curve No 1, which represents the condition found to exist in heat treated 51S sheet as welded, shows that at a point ¼ in from the weld the sheet is in the heat treated condition At a point one inch from the weld, which was found to be the softest area, a very slight annealing has taken place. The Brinell number for fully annealed 51S sheet is about 28, while the Brinell number at this soft area is 50 The Brinell number for heat treated 51S sheet is about 63 For the heat treated and artificially aged material the Brinell number is about 95 As we move farther away from the weld, the Brinell numbers show an increase in hardness until a maximum is reached at a point three inches from the weld This point represents an area in which a slight artificial ageing has occurred Beyond this area there is a slight decrease in hardness until a point four inches from the weld is reached Beyond this point the temper of the sheet has not been affected by the heat of welding

Curve No 2 represents the condition found to exist in a specimen of heat treated 51S sheet that was artificially aged after welding In the partially annealed area one inch from the weld aging has not had much effect However, at a point two inches from the weld, the sheet has been fully aged.

Duralumin is extremely hot-short and care must be taken to avoid contraction strains when welding this alloy Such strains may be minimized by preheating or when this is not feasible, by observing such a sequence in assembling the article to be welded that the metal adjacent to the weld will be free to contract without setting up undue strains on the weld. Perhaps one of the best means of preventing cracking from contraction strains is to use a 5 per cent silicon welding rod As previously stated, this alloy has a lower melting point than duralumin, hence remains molten after the base metal has solidified This permits the weld metal to fill in the voids caused by the solidification contraction of the base metal Furthermore, the stresses due to contraction shift their effects from the base metal to the weld metal, which being free from hot shortness, will stand the stresses without the development of cracks

When a broken aluminum casting is to be welded, it should first be cleaned carefully, removing every trace of oil, grease and dirt by means of a wire brush and gasoline Unless the casting has a very heavy cross section, it is not necessary to tool the crack or cut out a vee If the casting has a piece broken out of it, the piece or pieces should be held in correct position by light iron bars and appropriate clamps, the clamps being so attached as to avoid straining any portion of the casting, especially the thin walls (when near the melting point the metal is very weak and will crumble under slight strains) The casting, particularly if a large one, should be preheated Many expert welders are able to do splendid work without preheating, but this ability results from long experience If the casting to be welded is small, or if the weld is near the edge and in a thin walled section, the torch flame may be played over the pieces so as to preheat them before starting to weld The cold aluminum should be heated slowly. A quick heat will crack the metal near the flame

To consider again the broken crank case already mentioned, as soon as the casting is properly preheated, it is tack welded at points A and B (Fig 8) Then starting at the middle of the break weld toward the ends Welding rod is added by holding the tip of the rod in the flame near the metal Contrary to welding practice on steel or cast iron, the weld metal must be flowed into the weld by the flame, because the heat in the puddled metal will not melt aluminum When a few drops are melted off the welding rod, it is worked around and into place with a rubbing motion of the rod Care must be taken to get the new liquid metal to the bottom of the crack, all the time playing the torch about freely, but always with the tip about two inches from the metal

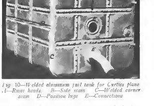


Fig 10—Welded aluminum fuel tank for Curtiss plane A—Rivet heads B—Side seam C—Welded corner seam D—Position lugs E—Connections

When the weld is finished the casting is annealed by adding four or five handfulls of charcoal and covering the furnace top with asbestos paper The fire is allowed to burn out slowly and the casting cooled in the furnace.

A charcoal furnace is not necessary when filling holes in castings The area is preheated locally by playing the

torch about the hole The hole should be shaped up so as to remove all pockets and to permit proper manipulation of the torch In filling blowholes the cavity should be thoroughly cleaned so that only clean metal is exposed The preparation of a tooth for filling by a dentist is an analogous operation

For filling holes and welding castings, it is usually preferable to use a weld metal of the same composition as the casting. However, in the case of complicated castings where severe contraction strains are liable to ensue, 5 per cent. silicon welding rod would be more desirable

Flux Should Be Used for Castings

A flux should be used when welding aluminum castings just the same as for sheet aluminum, however, there is no objection to puddling also Puddling will merely break up the oxide film and leave it incorporated in the weld metal, thus weakening the weld The flux will float the oxide particles to the surface and leave a clean sound weld.

As soon as the weld is finished and the work has had time to cool it should be thoroughly washed to remove all traces of flux If the flux is permitted to remain on the weld it will cause corrosion Therefore it is very important to be sure that every trace of flux is removed, particularly if the completed job is to be painted Merely cleaning by means of hot water and a scrubbing brush is not sufficient or thorough enough to remove the flux that may be in crevices or cracks which are not readily attacked by a brushing operation A more effective method of removing the flux is by means of a steam jet, the steam jet impinging upon the welded joint When a final sand blasting operation is used, the steam jet should be used both before and after sand blasting A still more efficacious scheme for removing the flux is to wash in a hot two per cent nitric acid solution or a warm ten per cent sulphuric acid solution In general, the flux removal may be very efficiently performed by first thoroughly soaking the welded article in a "first wash" tank of hot water for about three minutes, during which soaking period the welded joint should be thoroughly scrubbed with a brush to insure the removal of the bulk of the flux The article is then dipped in the acid tank for from three to five minutes, after which it is again dipped in the first wash tank and then thoroughly rinsed in a "final rinse" tank of hot water The washed articles, if small, may be dried in sawdust

Welds in aluminum are quite often untouched after completion, especially in the case of thin sheet metal where the weld should be so even that it is not unsightly. When desirable the weld can be made completely invisible by grinding off the excess metal and polishing the whole.

Welded aluminum joints have not been looked upon with much favor by the designers and builders of aircraft However, such joints are being used to some extent, particularly in gasoline tanks. Figures 10 and 11 are two different views of a gasoline tank built for the Curtiss company These tanks, which have a capacity of 113 gals, are built of light gauge sheet aluminum The baffle plates, shown in Fig 13, are held in place by rivets, the rivet heads being welded to the outside of the tank where they come through to prevent leaks All seams and all connections in the shell of the tanks are torch welded. Fig 12 is a wing tank built for the Curtiss Robertson company These tanks, which have a capacity of 26 gals, are also built of light gauge sheet aluminum The large tanks are tested to 5 8 lb per sq in and the small tanks are tested to 3 5 lb. per sq. in.

After welding the tanks are washed in warm water to remove the greater portion of the flux. They are then submerged for one hour in a warm ten per cent sulphuric acid solution to dissolve and remove all traces of the flux, after which the tanks are washed for one hour in running water The tanks are then tested by connecting a hose and completely submerging the tank in water, forcing in air and looking for leaks, which would be indicated by bubbles of air rising to the surface of the water. A mercury column is used for indicating the pressure as a pressure gauge is not sufficiently accurate

Aluminum Welding Not Difficult

The factors which have been discussed are the ones which, if not properly controlled or handled, offer the greatest potential difficulties in welding aluminum However, the welding of aluminum, and excellent welding too, is not a really difficult process Welding is a metallurgical process and is, consequently, governed largely by natural laws Excellent consistent results will be obtained if the principles involved are understood and employed correctly.

Fig 11

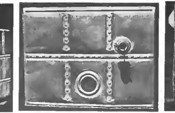


Fig 12

Fig. 13.

Fig. 11—Side view of a welded aluminum gasoline tank for the Curtiss company Fig 12—A welded aluminum wing tank for the Curtiss Robertson company Fig 13—Arrangement of baffle plates in tank

PATENTS ISSUED

Patent No 1,700,948—*Internal-Combustion Engine, John Scott Oliver, London, England One Claim* An internal combustion engine having a piston and a cylinder, a rotary sleeve valve, two sets of inlet and exhaust ports in the cylinder ports in said sleeve valve for registering alternately with the inlet and exhaust ports of each set, the first set of ports extending from a point at or near the head of the cylinder to a point intermediate in the stroke of the piston and being arranged to be opened and closed at the correct times by the movement of the sleeve alone while the second set of ports subtend the a wider angle than said first set of ports and extend from a point intermediate in the stroke of the piston to a point at or near the bottom of the stroke of the piston and are arranged to be opened and closed at the correct times by the movement of the piston in conjunction with the movement of the sleeve

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Patent No 1,701,274—*Control of Internal-Combustion Engines William Floyd Rebbidge, Ulverston, England, assignor to Vickers Limited, Westminster, London, England 11 Claims* In means for controlling variable speed internal combustion engines, an adjustable speed governor, a governor setting device, a fuel injection mechanism comprising a fuel pump, an injection valve, engine operated mechanism for actuating the said valve, means for operating part of the said mechanism under governor control to vary the duration of opening of said valve, a servo-motor having a controlling valve adjusted by the governor setting device, and a piston rod connected to the said governor controlled operating means so arranged as to vary the extent of the governor operated movement recording to the adjustment of the governor setting device

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Patent No 1,701,298—*Aeroplane John Dill, New York 25 Claims* A flying machine embodying a fuselage or nacelle, port and starboard wings mounted for pivotal movement on pivots supported from the fuselage, incidence adjusting struts secured to the wings, and complementary threaded members operatively connected to the struts and to the fuselage and adapted when operated, to move the struts longitudinally to vary the incidence of the wings, in combination with a propeller cable of adjustment to vary the pitch thereof, mechanism for adjusting the propeller, and unitary means operatively connected to both the propeller adjusting mechanism and to the threaded members and adapted when operated to simultaneously adjust the propellers and vary the incidence of the wings

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Patent No 1,701,089—*Control of Fuel-Injection Mechanism for Internal Combustion Engines Edward von Salis Winterthur, Switzerland, assignor to the Firm Sulzer Freres Societe Ananyme, Winterthur, Switzerland Three Claims* A liquid fuel injection system comprising an injection valve, a source of liquid fuel under pressure, means for supplying liquid fuel from said source to one end of said valve to maintain it in normally closed position, means for supplying liquid fuel from said source to the other end of said valve and trapping it therein, and means for reducing at a predetermined instant the pressure of said source, whereby the pressure of the liquid fuel trapped in said last named end overbalances the pressure of the liquid fuel supplied to said first named end and causes the opening of said valve

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Patent No. 1,701,204—*Aircraft Communication Apparatus Louis O Glatzner, Hasbrouck Heights, N J. 11Claims*

Patent No 1,701,451—*Airplane. Randolph F. Hall and Charles Ainsley Phillips, Ithaca, N. Y., assignors, by direct and means assignments, of three-fourths to said Randolph F. Hall and one-fourth to Theodore P. Hall, Wallingford, Conn Nine Claims* In a tapered aircraft element, a metal skin or covering therefor formed with a series of corrugations disposed longitudinally of the element and constant in number, and formed smooth between said series of corrugations to compensate for the element taper.

Patent No. 1,699,699—*Aeroplane Propeller Frank W. Jatunn, Troy, Mont. Five Claims.* In a propeller structure of the class described, a frame comprising a pair of side rails, a pair of bars, one slidable on each rail, a plurality of rungs between the rails, a plurality of rungs between the bars, flexible strips fixed to the rungs of the rails and to adjacent rungs of the bars, and means for sliding the bars in relation to the rails to spread and collapse the flexible strips.

Pateut No. 1,700,226—*Unattended Beacon Frank R House, Baldwin Harber, N. Y, assignor to The Sperry Gyroscope Company, Brooklyn, N. Y. 12 Claims*

Patent No 1,701,466—*Airship Benjamin Schnitzer, Akron, O., assignor to Goodyear-Zeppelin Corp, Akron, O. Six Claims.* The combination with an airship comprising a hull portion having an inflatable gas cell therein and a gas bag disposed within the hull portion, cooperating with the gas cell to occupy the space within the hull portion, of a lifting gas for inflating the gas cell, and a combustible gas heavier than the lifting gas for inflating the gas bag

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Patent No 1,701,648—*Rotary Internal-Combustion Engine Ira F Wildey, Chicago, Ill, assignor of forty-five one-hundreddths to James M Ross, Chicago, Ill Four Claims* In an internal combustion engine, cylinders arranged with their axis forming axis of the circumference of a circle, a rotatable mounting therefor, pistons in said cylinders, a rotatable mounting therefore, separate multiple lobe cam gears connected to said mountings, and relatively fixed eccentic pionions meshing with said cam gears and adapted to cause oscillating relative movement between said cylinders and pistons.

Patent No 1,701,407— *Aircraft Rogelio Garcia, New York, N. Y. Five Claims* A landing gear for aircraft of the character described including supporting wheels and vertical standards in which the wheels are journaled at the lower end, said standards having wedge shaped portions and yieldable wedge shaped means coacting with said wedge shaped portions.

Patent No. 1,701,762—*Helicopter-Control Mechanism. Harold F Pitcairn, Bryn Athyn, Pa Eleven Claims* In an aircraft, the combination of a universally mounted rotatable propeller and means adapted to ultilize the gyroscopic force set up by its rotation to control its angular position with relating to the aircraft

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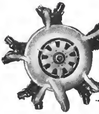
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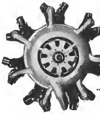
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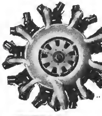
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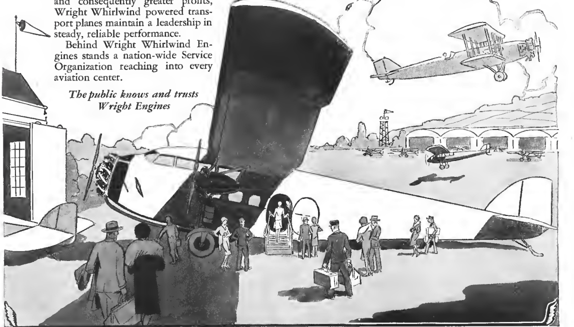

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